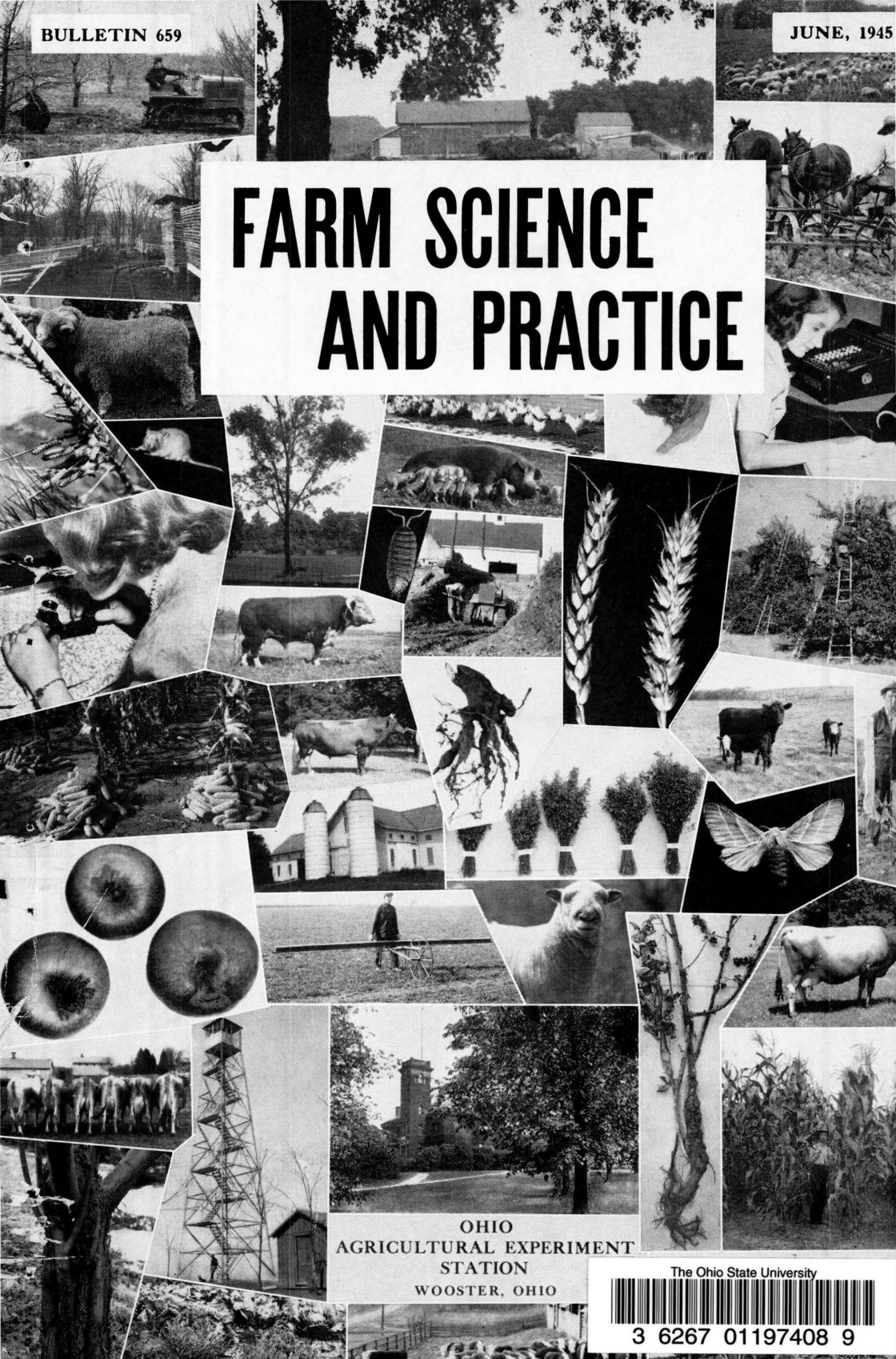
BULLETIN 659

JUNE, 1945



FARM SCIENCE AND PRACTICE

OHIO
AGRICULTURAL EXPERIMENT
STATION
WOOSTER, OHIO

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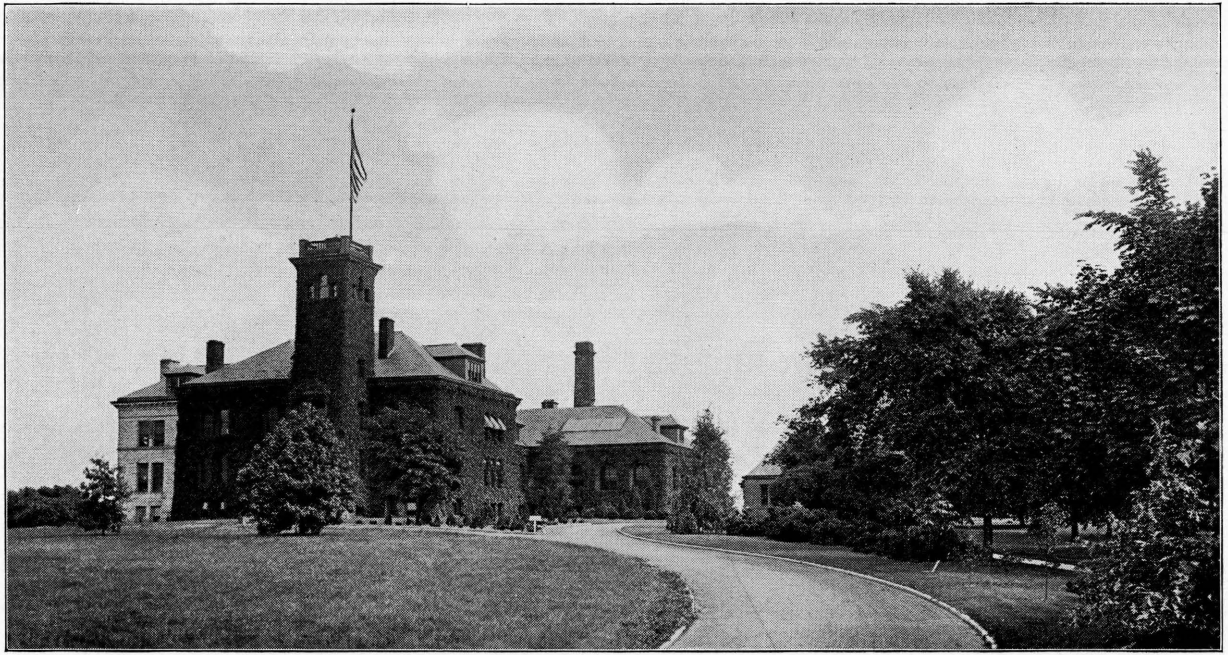
Farm Science and Practice

Sixty-third Annual Report
of the Ohio Agricultural
Experiment Station for the
Year ended June 30, 1944

PUBLISHED BY THE ORDER OF THE STATE LEGISLATURE

Wooster, Ohio
Experiment Station Press
1945



The Administration Building

The Honorable Col. Carlton S. Dargusch
President of the Board of Control
Ohio Agricultural Experiment Station

Dear Sir:

I have the honor to present to the Board of Control for transmission to the Governor of Ohio, as required by law, the sixty-third annual report of the Ohio Agricultural Experiment Station for the year ended June 30, 1944.

Edmund Secrest
Director

The Honorable John W. Bricker
Governor of Ohio

Dear Sir:

I have the honor to present to you the sixty-third annual report of the Ohio Agricultural Experiment Station for the year ended June 30, 1944.

Col. Carlton S. Dargusch
President, Board of Control

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*Military Leave.
[1]In Cooperation with the U. S. Department of Agriculture.

CONTENTS

FOREWORD

For 60 years the workers in our experiment stations have been developing techniques that make possible the high standards of American agriculture, and that, incidentally, have made it possible for us to supply our own food and a large part of that needed by our allies during two World Wars.

The farmers of Ohio have done a magnificent service in meeting the production goals set for Ohio during the period of World War II, and they have operated under many handicaps. Lack of manpower, materials, and equipment has greatly increased the load the growers have carried.

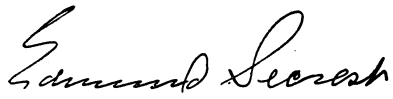
The efficiency of the Ohio farmer is due, in most part, to intelligence and business acumen. However, to supplement these qualities there is the background of agricultural science which has developed as a result of the scientific research carried on over a period of 60 years by the State Agricultural Experiment Stations of America. This information has been disseminated by the Agricultural Extension Services and Colleges of Agriculture, by the Stations themselves, and by the farm press. Because this information has been put in practice we see the following improvements on our farms: Methods of maintaining soil productivity have been developed to a considerable degree; fertilization and crop rotations have increased crop yields; plant and animal breeding has increased both the production and quality of food products; and distribution of products to the consumer has been facilitated by studies in this field.

Likewise, science has contributed the machinery which has enabled the farmer to mechanize his farm operations so that now only 20 per cent of our population is required to produce all of the food we need, as compared with 80 per cent in the early days of the Nation. Farm machinery and equipment have also been invented and improved by the research workers.

Since the beginning of the war emergency the Station has dropped some projects, revised others, and initiated new ones in order to confine its work to problems directly bearing on the production of food and related activities. Work on projects fundamental in nature and those covering longer periods to attain objectives is being continued.

The Ohio Station is cooperating with the stations in 12 states in the north central region on projects in which there is mutual interest. This coordination of effort has brought out information of much service for the present emergency and by pooling objectives has accomplished results at a minimum of cost.

The discussion of activities contained herein does not cover all projects under way at the Station. It is intended to enlarge upon those of most current interest.



Director

Farm Income and Living

ATTAINING MAXIMUM AGRICULTURAL PRODUCTION IN OHIO IN 1945

The Experiment Station was asked in 1944 to make an estimate of the crop and livestock production which might be desirable in Ohio in the year 1945, assuming that wartime needs continued.

Among the suggested changes were: A slight reduction in the soybean acreage; a material increase in the wheat acreage; and a reduction in the corn acreage below that of 1944. It was proposed that the acreage of sod crops be increased by 10 per cent over that of 1944. Emphasis was given to the desirability of attaining increased crop production through increasing the yield per acre rather than by expanding the acreage. The acreages suggested would not result in a use of the land which would maintain its productivity; it would, however, result in an improvement in this respect and, at the same time, maintain a high level of production during the year 1945. With the adoption of good soil and crop practices and with an improvement in the quality of grass crops the suggested adjustment would not result in a decrease in the carrying capacity for livestock.

J. I. Falconer

POST-WAR PROBLEMS OF OHIO AGRICULTURE

Among the projects undertaken during the year was the formulation of a statement relating to some of the problems which would confront Ohio agriculture in the postwar period.

It was estimated that at the end of the war in Europe, Ohio farms could absorb in the neighborhood of 50,000 new agricultural workers. This would not mean an increase of that amount in number of workers, since a large per cent of the new workers would take the place of male workers seeking to retire because of old age and of women and children now working. There seems to be no reason to expect that the present trend toward the adoption of labor-saving practices and devices will not continue. The conclusion was arrived at that, given reasonably good prices after the war, there might well be a building and improvement program on Ohio farms to the extent of $750,000,000.

Attention will need to be given in the postwar period to the restoring of our soil productivity. Heavy cropping and erosion have stepped up the rate of depletion during the war years. The acreage of sod crops should be increased, and more attention should be given to liming and erosion control. The development of the 5,000,000 acres of forest and potential forest land in the State is urgently needed.

J. I. Falconer

WAR RELOCATION OF SUBSISTENCE FARMERS

From November 1942 through March 1943 the Farm Security Administration, in cooperation with the United States Employment Service and The Ohio State University, aided in the relocation of workers and their families from comparatively unproductive farms in eastern Kentucky to Ohio for training and placement as farm laborers. A total of 316 men were transported to a residence center at the University for orientation and placement on farms in Ohio. A study of the occupational and social adjustments of these relocated people was carried on through October 1943.

Of the 316 workers transported from Kentucky to Ohio who were included in the study, 214 were hired by Ohio farmers. In August 1943, 5 to 9 months after their employment, it was found that only 101 remained in their original farm jobs in Ohio. The majority of these who moved went back to Kentucky or into some non-farm employment.

It was found that the relocation of people from the hills of Kentucky to the commercial and mechanized farming areas of Ohio involved the workers and their families in difficult problems of personal and social adjustment. The workers most successful in making the readjustment included those in the age range of 20-40 years who had had at least eight grades of schooling. They were from the best of the hill farms in Kentucky and had been tenants rather than landowners. They had at least average intelligence and were physically fit and emotionally stable.

A. R. Mangus and R. L. McNamara

PRICE TENDENCIES IN FARM LAND OF HIGH AND LOW PRODUCTIVITY

Land price inflation and the subsequent deflation contributed to the financial ruin of numerous farmers following World War I. There is some danger that a similar situation may follow World

War II. An analysis covering more than 1700 tracts of farm real estate sold in the period of January 1941 to July 1944 depicts one of the principal danger points in the farm real estate market; namely, the tendency in an inflationary period for the price of land of low-productive capacity to advance relatively faster than the price of land of high-productive capacity. That this tendency existed during the last period of rising land prices has been emphasized by the observation that the majority of farms involved in financial distress during the late 1920's and early 1930's were lands of poor productive capacity purchased a few years previously when prices were inflated.

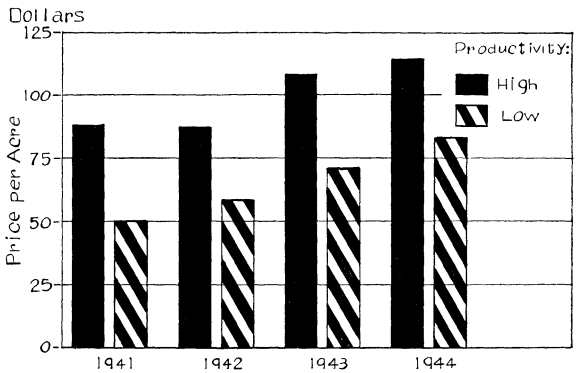


Fig. 1.—Price trends of different grades of land, sample of farm real estate sales, Ohio, 1941—July 1944

The general level of farm real estate prices in Ohio advanced from an index value of 80 as of March 1941 to 111 in March 1944, a change of 39 per cent. As indicated by this study, the advance was by no means uniformly applicable to all grades of land. There was a price advance of 28 per cent for the better lands and of 58 per cent for the poorer lands.

H. R. Moore

DETAILED STUDIES OF HEALTH AND HUMAN RESOURCES IN OHIO REVEALED SOME NOTABLE FACTS

1. Death rates among infants, children, youths, and very old people were generally higher in rural areas than in the cities where health services and facilities are more adequate. Death rates were highest of all in the economically and socially disadvantaged rural areas.

2. About 6 out of each 10 white men from typical rural areas in Ohio, who were examined for Selective Service during a recent year, had one or more significant health defects. Nearly 4 of each 10 registrants examined had defects serious enough to cause their rejection for general military service.

3. The leading causes for rejection of rural men were, in order of importance, mental illness, eye defects, defects of the heart and blood vessels, defects of the muscles, bones, and joints, and hernia.

4. Doctors, dentists, and hospitals, as well as other health services and facilities, were heavily concentrated in the large cities and were least adequate where levels of living were lowest. Before the war, the Ohio counties with the eight largest cities had 160 doctors, 70 dentists, and 383 general hospital beds for each 100,000 of the population. The remainder of the State, including most of the rural population, had only 91 doctors, 39 dentists, and 159 general hospital beds per 100,000 people. The most disadvantaged rural area in Ohio had only 75 doctors, 31 dentists, and 113 general hospital beds per 100,000 people.

5. A much larger proportion of rural than of urban doctors and dentists were aged men who had passed the peak of their effectivity as practitioners.

A. R. Mangus

PREPAID MEDICAL CARE FOR LOW-INCOME FARM FAMILIES

A study was made of a sample of 680 farm families that received medical care under prepayment plans sponsored by the Farm Security Administration for clients of that agency. The ailments most frequently treated were respiratory disorders (including colds, influenza, and bronchitis), diseases of the digestive system, diseases of the reproductive organs (particularly among women), nervous diseases, and circulatory disorders. Women received a greater volume of physicians' services than men, and adults were treated much more often than children. It was significant that under the prepayment plan persons of lowest economic status received on the average more medical service than did those of higher economic status. This is a reversal of the usual situation in which the poorest farm families receive the least medical care.

A. R. Mangus and R. L. McNamara

COUNTRY TRANSPORTATION OF MILK

By rerouting milk trucks in Ohio milk-market areas, substantial savings in mileage could be made in the assembling of milk. The extent of such savings would amount to 26 per cent of present driving for the Columbus market, 11 per cent for Cleveland, 9.4 per cent for Carroll County, 7 per cent for Canton, and no change in the Portsmouth market. These savings could be made by eliminating duplication of driving over roads in picking up milk and by consolidating loads where possible.

In the study no account was taken of the possibilities of saving truck mileage by the elimination of overlapping of market areas. Due to differences in inspection between markets, the problem of eliminating wastes from such overlapping of milk routes was not included in the survey. In most markets such possibilities would be small while in a few it would be large.

R. W. Sherman

FACTORS AFFECTING MILK SUPPLY IN AKRON, CANTON, DAYTON, AND PORTSMOUTH, OHIO

It was found in a study of factors affecting milk supply in Akron, Canton, Dayton, and Portsmouth that withdrawals of producers exceeded additions but that with a decrease in number of producers shipping there was an upward trend in the total pounds of milk received in these markets. This trend is shown in figure 2 for a 10-year period, 1934-1943, in the Portsmouth market area.

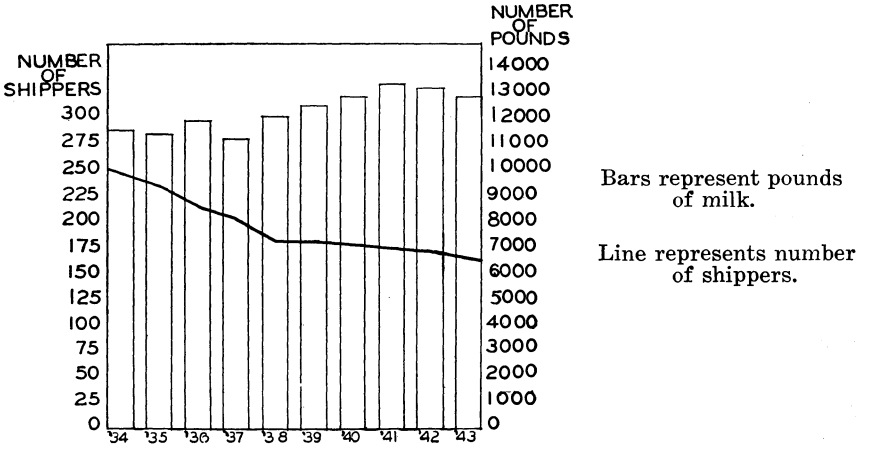


Fig. 2.—Average number of shippers and average shipments in pounds per year in Portsmouth market, 1934-1943.

When farms were classified on a basis of average deliveries, the heaviest gains in farm sales were found to be in the middle group. Withdrawals were heaviest in the farms with heavy production and in the farms with low production.

C. G. McBride and R. W. Sherman

RELATIONSHIPS BETWEEN COOPERATIVE ORGANIZATIONS

A study by the Department of Rural Economics, in cooperation with the Farm Credit Administration, during the latter part of 1943 and 1944 showed that Agricultural Cooperatives are not working as closely together as many cooperatives would like; farmers particularly feel that too many of the cooperatives are inclined to work individually. Relationships could be improved by the holding of joint educational meetings.

It was also suggested that cooperatives should form informal cooperative luncheon or dinner clubs. All the senior and junior cooperative employees in a county, for example, should be brought together for general meetings and good fellowship in order to become better acquainted.

Transporting commodities to market and farm supplies from such markets back to the cooperatives, in some instances, offered possibilities of saving.

Some cooperators visualized the day when cooperatives would locate their facilities, warehouses, offices, etc., in one trading center so that a member could trade, deal, or purchase supplies in one spot instead of having to go all over town as they must do at present. Recently some counties have moved in the direction of establishing cooperative trading centers.

While more than three-fourths of the members studied were satisfied with their cooperatives there were some dissatisfactions. The more important were: (1) the cooperative is too far away; (2) improved service is needed; (3) management is not satisfactory; (4) merchandise handled is too limited; (5) prices received or paid were unsatisfactory; and (6) facilities were too small.

Cooperative members strongly favored the idea of keeping cooperatives democratic; for example, three-fourths of the members stated that the directors' terms should be limited to 8 or 9 years of continuous service. After serving for such a length of time, they should be ineligible for re-election for a period of 2 or 3 years. This would provide for the rotation of directors and would bring in new thinking.

In connection with this study patrons gave their suggestions for new lines of attack or new developments to be undertaken by cooperatives. These were in order of importance: (1) move into the field of processing and manufacturing such as meat processing, canning, and manufacturing farm machinery, (2) operate new cooperative services such as group hospitalization and medicine, banking, and burial associations, (3) develop more branches and services, (4) handle surplus milk more advantageously, and (5) increase membership.

Geo. F. Henning

Soil Management

ALFALFA IN THE ROTATION INCREASES GRAIN YIELDS AND DIGESTIBLE NUTRIENTS PER ACRE

I. Decreasing the number of corn crops and increasing the number of alfalfa crops.

The effect of increasing the number of crops of alfalfa at the expense of an equal number of corn crops in the rotation is illustrated by three 5-year rotations in the Fry Farm Crop Rotation

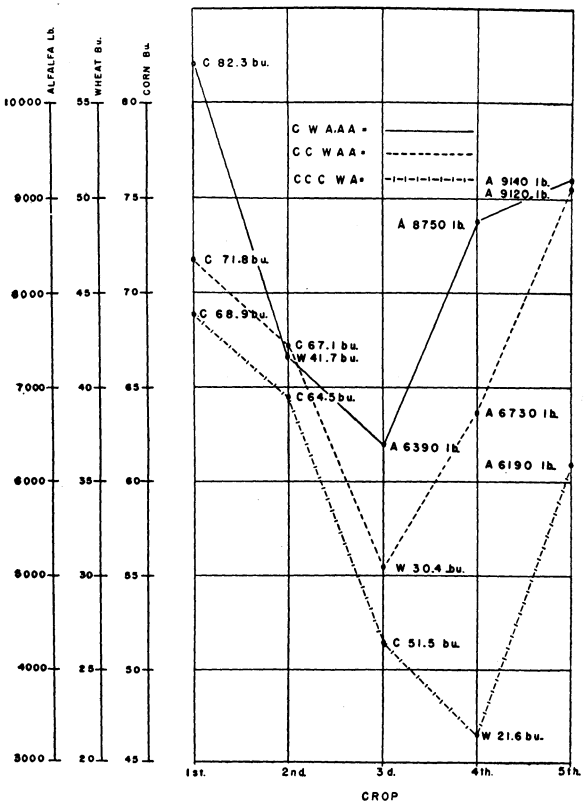


Fig. 3.—Yield of corn, wheat, and alfalfa in 5-year rotations—Ohio Agricultural Experiment Station, Wooster, Ohio

Experiment at Wooster. The rotations are (A) 3 years of corn, 1 of wheat, and 1 of alfalfa; (B) 2 years of corn, 1 of wheat, and 2 of alfalfa; and (C) 1 year of corn, 1 of wheat, and 3 of alfalfa.

The 6-year average yield of crops is shown in figure 3. Decreasing the corn crops and increasing the alfalfa resulted in an increase in the yields of corn and wheat.

The calculated annual production of digestible nutrients[1] per acre by these crops in the above rotations was (A) 290 pounds of digestible protein and 2780 pounds of total digestible nutrients (T. D. N.); (B) 440 pounds of digestible protein and 3060 pounds of total digestible nutrients; and (C) 560 pounds of digestible protein and 3320 pounds of total digestible nutrients. The wheat straw was not used in making these calculations.

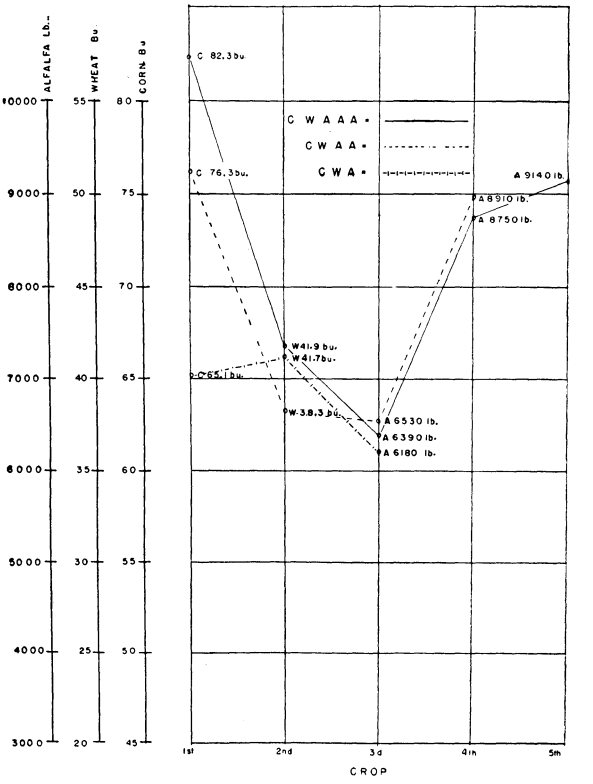


Fig. 4.—Yields of corn, wheat, and alfalfa in 3-year, 4-year, and 5-year rotations—Ohio Agricultural Experiment Station, Wooster, Ohio

[1]Morrison's table of average composition and digestible nutrients (table 1) in Morrison's Feeds and Feeding, 20th edition, was used in these calculations.

Rotation (C) may consist of too much alfalfa and not enough corn for some types of livestock farming. Rotation (B) is better balanced in this regard.

II. Lengthening the rotation by increasing the number of years in alfalfa.

The effect of lengthening the rotation by increasing the alfalfa is illustrated by three rotations in this experiment. (E) A 3-year rotation of corn, wheat, and alfalfa; (D) a 4-year rotation of corn, wheat, and 2 years of alfalfa; and (C) the same 5-year rotation of corn, wheat, and 3 years of alfalfa discussed above in I.

The 6-year average yields of crops are shown in figure 4. The main effect of increasing the number of years in alfalfa was to increase the yield of corn. The yields of wheat following the 1 year of corn were fairly close and so also were the yields of the first year of alfalfa. This suggests that the pronounced drop in the wheat yields shown in figure 3 was due mainly to the preceding increased number of corn crops rather than to the decrease in the number of alfalfa crops.

The calculated annual production of digestible nutrients per acre was (E) 430 pounds of digestible nutrients and 3240 pounds of total digestible nutrients and in (D) 585 pounds of digestible protein and 3700 pounds of total digestible nutrients. (D) has a very satisfactory production record. (See I for the record of (C).)

L. E. Thatcher

ALFALFA, ALL IMPORTANT

The SOUTHEASTERN EXPERIMENT FARM is rather typical of many hill farms that rapidly are being converted to strip-farming methods for soil erosion control. On this farm the plan is to use a 4-year rotation with 2 years of meadow. The fullest success with the second-year meadow in this area of southeastern Ohio depends on getting a satisfactory stand of alfalfa in wheat. Experiences at this Farm and also at the WASHINGTON COUNTY EXPERIMENT FARM indicate that the problem is far from solved by merely building a high state of soil fertility through the use of limestone, fertilizers, and manure. Excessive wheat growth too frequently results in a poor stand of alfalfa. Thus, in a heavy fertilization test at the Southeastern Experiment Farm in which all crops were fertilized—the wheat getting 500 pounds of 2-10-8 per acre at seeding time—the difficulty of getting a stand of alfalfa was increased in certain years when the season was favorable for

excessive straw growth. At the Washington County Experiment Farm on highly fertile soil, excellent one-year meadows are secured on plots where the wheat is topdressed with sheep manure but larger yields of hay are obtained when the manure is applied to the meadow itself. In neither case is there a very high percentage of years when the alfalfa in the mixture is sufficiently good to make a satisfactory second-year meadow.

M. A. Bachtell, R. E. Yoder, Ray Hopkins, and Elza McCall

CROWN VETCH AS A HIGHWAY BANK COVER

One of the outstanding events of the twentieth century is the change in means of terrestial transportation. The automobile called for good roads; highways not only with hard surface but pikes devoid of steep grades. To meet this latter requirement much road reconstruction was necessary, involving the reduction of hills and the filling of vales. This leveling process left exposed on roadsides large expanses of unsightly, infertile subsoil, which was subject to washing. To find a cover that could be established at moderate cost without molycoddling and that would subsist on barren, often rocky, yellow soil devoid of organic matter, and at the same time prevent erosion and present an attractive appearance to the traveling public, has been a problem. Much of the newly exposed roadside still remains unimproved; it is either bare or inhabited by weeds and is becoming increasingly gullied.

Apparently crown vetch (*Coronilla varia*) meets all requirements. The plant will grow on the poorest soil without the use of either manure or fertilizers. Since it is a legume, it derives nitrogen from the atmosphere; furthermore, on account of its deep and extensive root system, the volume of soil from which it may absorb minerals is large. At the same time, the deep and extensive root system militates effectively against excessive washing. A good stand of crown vetch affords a green covering throughout the growing season. The plants "green up" early in the spring, make a luxuriant growth during the summer, and retain their verdure until cold weather. Moreover, in June its attractiveness is enhanced by the development of beautiful pink flowers about an inch in diameter which remain objects of admiration for 2 or 3 weeks.

Unfortunately the plant does not seed readily; consequently, multiplication is restricted to vegetative propagation. This can be accomplished by digging up the fleshy rootstocks and planting and

covering the broken, uneven, and irregular-sized segments (1½ to 2 ft.) in conveniently spaced slits made with a spade or some similar tool. The planting can be done in either spring or fall.

The roadside cover shown in figure 5 was planted September 20, 1938 and was photographed June 26, 1941.

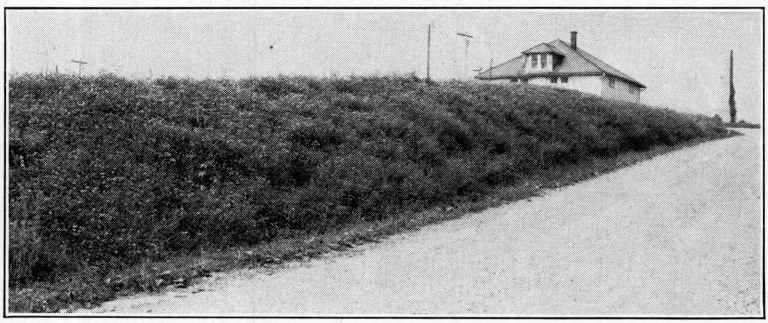


Fig. 5.—Crown vetch (*Coronilla varia*) as a highway bank cover

On account of its aggressive nature, crown vetch is not as well suited for planting in more or less restricted areas around the home as it is in the wide open space along roadsides. It can, however, be kept in bounds by the use of a sodium chlorate solution (at least 1 pound per gallon of water) applied as a spray at the rate of 10 gallons per 1000 square feet.

F. A. Welton

PLOWING UNDER HEAVY APPLICATIONS OF FERTILIZER

During the past 3 years some 20 field experiments have been conducted on plowing under heavy applications of fertilizers for row crops on the major soil types of Ohio. Results obtained with corn on Wooster-Canfield silt loams at Wooster are typical of the wide range of responses obtained under different soil and climatic conditions. The 1943 season was unusually favorable; whereas 1944 was characterized by an extremely severe drought.

Fertilizer rate, grade, and placement*		Corn yields, in bushels per acre			
Row	Plow-down	1942	1943	1944	3-year average
400 lb. 12-12-12	None	85.0	93.5	20.3	66.3
100 lb. 12-12-12	300 lb. 12-12-12 B. O. F. B.	82.7	97.3	16.7	65.6
400 lb. 0-12-12	400 lb. 12-0-0 B. O. F. B.	87.5	94.2	23.1	64.9
None	400 lb. 12-12-12 B. O. F. B.	65.5	93.2	24.4	61.0
None	400 lb. 12-12-12 Bdc.	72.8	84.2	16.2†	57.7
None	400 lb. 12-12-12 Surface bdc	55.3	93.3	15.6†	54.7

*All treatments total the same amount of fertilizer. B. O. F. B.=banded on furrow bottom; Bdc.=broadcast before plowing; surface bdc.=broadcast after plowing.

†1944 yield not strictly comparable; one-fourth of total fertilizer was used as starter placed in row with planter.

The fertilizer placement work conducted on a State-wide basis supports the following tentative conclusions:—

1. Plowing down heavy applications of fertilizer for corn has not been profitable under all conditions. Plow-down fertilization has been no more effective in increasing yields than other methods of applications under extreme drought conditions.

2. The outstanding yield increases frequently obtained from heavy plow-down fertilizer applications under favorable conditions is simply the normal response of the crop to increased rates of fertilization.

3. Broadcasting of phosphate-containing fertilizers is an inefficient method of application, irrespective of depth of placement.

4. Plow-down fertilizer applications, if used, should be made in *addition* to conventional hill or row applications and *not* at the expense of fertilizer applied in close proximity to the seed. Thicker than average stands of corn must be obtained if the full benefits of heavy fertilization are to be realized. On land where yields of 70 bushels or more per acre may be expected, this means that planting rates should be increased from 3 kernels to 4 kernels per hill, or its equivalent if the corn is drilled.

5. Some phosphate and potash banded in close proximity to the seed are necessary for early growth and they definitely promote early maturity of most crops. All of the fertilizer to small grains should be applied with the drill at the time of the seeding operation.

6. Straight nitrogen fertilizer should be broadcast for ordinary row crops prior to plowing. This method of application is safe and more effective than surface broadcasting or delayed side dressings for row crops such as corn and sugar beets.

7. Where supplemental mineral fertilization (phosphate-potash) is required, the material should be banded on the furrow bottom using the plow attachment. The operation is rather time-consuming however.

8. Much more experimental work and many more field trials under farm conditions must be conducted before it is possible to make general recommendations on plowing under of complete fertilizers, except in the cases of hybrid corn for seed production, sugar beets, and similar high-acre value crops.

R. E. Yoder

CHEMICAL NITROGEN PLOWED UNDER WITH CARBONACEOUS RESIDUES EFFECTIVE IN INCREASING CORN YIELDS

In all probability large amounts of chemical nitrogen will be available for fertilizer usage in the post-war period. Recent experiments indicate that one of the most effective uses for such fertilizer materials is where grass sods, straw, corn stalks, soybean straw, or similar low-nitrogen materials are to be plowed under for corn. In favorable seasons, corn yields will be increased at a rate of 1 bushel for each 2 to 2¼ pounds of nitrogen added up to application rates of 40 to 60 pounds of nitrogen per acre. Returns will be much lower in drought seasons.

The following results were obtained in a favorable season when corn followed an old timothy sod:

Pounds of sulfate of ammonia applied per acre*	None	100	200	400
Corn yields in bushels per acre	33.8	46.8	60.3	73.7

*Sulfate of ammonia was broadcast before plowing; liberal mineral fertilization was used in addition to the nitrogen.

If heavy nitrogen fertilization is used along with carbonaceous residues as a temporary substitute for legume sods for corn, a liberal mineral fertilizer application should be *drilled* in the row at planting time with the planter; 300 pounds of 3-12-12 per acre is recommended. The nitrogen should be broadcast with a grain drill prior to plowing. Proper balance between nitrogen, phosphate, and potash must be maintained in order to obtain best results for heavy applications of nitrogen.

R. E. Yoder

POTASH BECOMING A MORE IMPORTANT LIMITING FACTOR FOR CROP PRODUCTION

The early experimental work at the Ohio Experiment Station showed a very general response to the use of phosphate fertilizers. Potash, on the other hand, was not generally deficient; however, the response to this element has become gradually greater until within recent years it has become pronounced. Coincident with the beginning of the use of lime in experimental work at this Station, which occurred in the early years of this century, a notable increase in the response to potash can be noted in the record of the older experiments. This fact is illustrated in table 1, which shows the yields from the 5-year rotation experiments.

TABLE 1.—Increases in yield of corn obtained from the use of superphosphate (plot 2) and potash (plot 3)

	Plot 2 (phosphate)		Plot 3 (potash)	
	East end (unlimed)	West end (limed)	East end (unlimed)	West end (limed)
	Bu.	*Bu.*	*Bu.*	*Bu.*
1900-04	12.3	11.1	8.2	4.0
1905-09	9.6	7.0	8.0	6.0
1910-14	7.5	8.6	3.0	4.3
1915-19	8.0	3.5	7.1	13.9
1920-24	5.0	2.9	5.3	16.2
1925-29	7.7	3.0	3.3	21.6
1930-34	3.3	4.4	3.8	13.7

On plot 2 the increase from phosphate has steadily decreased on both the limed and unlimed land, while on plot 3 potash has become less effective with time on the unlimed land and more effective on the limed land. Many other data can be cited which shows that after liming the response to phosphate tends to become less and that to potash more.

An extreme case of potash deficiency has recently developed in the Sweetclover for Green Manure Experiment. This experiment was started in 1926 and yields have been recorded since 1930. On most of the plots a basic treatment of limestone and superphosphate has been used. In table 2, the yields of four treated plots and the average of the checks are shown. All of these plots received the same basic treatment of lime and superphosphate. The rotation has been corn and oats. Sweetclover was seeded in the oats to be plowed down for corn on plots 6, 9, and 17, while on the two manure plots (11 and 12) and on the checks, no sweetclover catch crop has been seeded.

TABLE 2.—Sweetclover for green manure experiment

Plot	Treatment	Average yield		
		1930-35	1936-41	1942-43
		Bu.	*Bu.*	*Bu.*
Checks	No special treatment	43.8	48.4	20.8
6	Sweetclover catch crop	51.8	64.8	26.1
9	Sweetclover catch crop—82 pounds muriate of potash each rotation	53.9	76.7	30.7
11	4 tons manure on corn	54.4	76.5	40.2
12	8 tons manure on corn	54.5	79.4	50.4
17	Residues (straw and stover) plowed down for corn	61.4	82.9	57.9

In the first period (1930 to 1935), open-pollinated corn was used; in the second and third periods, W17 hybrid has been used. The better yields in the second period as compared to the first perhaps reflect mostly the better yielding ability of hybrid corn over open-pollinated. The severe drop in yields in the third 2-year

period is without doubt related to exhaustion of the supply of readily available potash. This is shown by the fact that, on the checks and on plot 6 which received no potash in any form, the reduction in yield has been the most severe. Plot 9, which has received a small application of potash, has suffered a smaller decline. The manure plot which received more potash has declined still less. The plot having the smallest decline is plot 17 which received the largest return of potash in the form of residues.

E. E. Barnes and R. E. Yoder

PLOWING INCREASES CORN YIELD

The Departments of Agronomy and Agricultural Engineering, cooperating, have, for the past 7 years, conducted experiments comparing the effects of different methods of tillage on the growth and yield of crops, particularly of corn, in a 3-year corn, wheat, alfalfa-clover-timothy hay rotation on Miami-Brookston soils. All treatments and practices have been the same except the preparation of the sod land for corn. The treatments compared have been:

1. Sweeps at the surface to kill vegetation. Crop residues remain at the surface.
2. Subsurface tillage plus use of sweeps at the surface to kill vegetation. Subsurface tillage lifts and slightly breaks the soil to a depth of 8 inches without inverting it. Crop residues remain at the surface.
3. Rototilling-preparation of seedbed in one operation with a high speed rotary machine which finely divides and completely mixes the top 7 inches of soil.
4. Plowing with special sod plow which completely inverts the furrow slice, followed by a minimum of seedbed preparation before planting.
5. Normal preparation (plowing, several diskings).
6. Normal preparation plus a 2-ton-per-acre straw mulch applied just after the first cultivation.

The 7-year average yields of corn are as follows:

Method of seedbed preparation	Corn, yield per acre
	Bu.
1. Surface only	36.2
2. Subsurface tillage plus surface	39.5
3. Rototiller	43.9
4. Sod plow	46.8
5. Normal	47.2
6. Normal plus mulch	51.3

Treatments 4 and 5, in which the land is plowed, have given an average advantage of 8 bushels per acre over treatments 1 and 2, in which the land was not plowed. It appears that plowing sod for corn produces larger yields under average Ohio conditions than methods which do not loosen and so aerate the soil as plowing does. The rototiller gave good results in a dry season, but very poor results in wet seasons when the excessively worked soil settled to a cement-like structure. Mulching corn is not yet practical, despite apparent increases in yield.

J. B. Page, G. W. McCuen, and C. J. Willard

A LIVESTOCK VERSUS A GRAIN ROTATION

The original Livestock versus Grain System of Farming Experiment was started in 1910 and continued until 1939. The rotations were: for the livestock—corn, soybeans (grain), wheat, and mixed hay; and for the grain—corn, soybeans (grain), wheat, and hay (not harvested). Sweetclover for seed was substituted for the hay in the Grain rotation in 1929.

Beginning with the crop season of 1940, the plan was revised to consist of two 3-year rotations as follows. Livestock—corn, wheat, and mixed alfalfa-clover-timothy hay; Grain—corn, soybeans (grain), and wheat (a catch crop of sweetclover being seeded in the wheat to be plowed for the corn).

In the Livestock rotation, the corn is cut and shocked, the wheat is cut with a binder and the straw saved, and the mixed alfalfa-clover-timothy is cut for hay. Manure in an amount equal to one and one-half times the total weight of crops harvested in the Livestock rotation (exclusive of the wheat grain) is returned to the land; two-thirds of the amount is spread on the sod going to corn and one-third is used as a winter topdressing on the wheat.

In the Grain rotation, the corn is husked from the stalk, the soybeans and wheat are harvested with the combine and the straw is left on the land. A cover crop of rye is drilled in the standing corn early in September and plowed in the spring for soybeans.

The applications of fertilizer are the same for both rotations; namely, 200 pounds per acre of a 2-12-6 in the row for the corn and 300 pounds drilled with the wheat.

The land is limed when needed to maintain the reaction to pH 6.5 to 7.0.

Table 3 gives the yields of crops and of calculated digestible nutrients per acre for the 3-year period 1942-1944, inclusive. The records for 1940 and 1941 are omitted because they were influenced by the previous 4-year rotations.

TABLE 3.—Three-year average yield of crops and of digestible nutrients per acre in the livestock and grain rotations—Wooster, Ohio

Livestock rotation					Grain rotation			
		Digestible protein	Total digestible nutrients	Manure applied			Digestible protein	Total digestible nutrients
		Lb.	*Lb.*	*Tons*			*Lb.*	*Lb.*
Corn, grain	62.6 bu.	250	2817	9.1	Corn	50.5 bu.	202	2272
Corn, stover	4992 lb.	105	2306					
Wheat, grain	41.4 bu.	281	2070	4.5	Soybeans	23.1 bu.	455	1194
Wheat, straw	3771 lb.							
Alfalfa-clover-timothy hay	5389 lb.	312	2737		Wheat	32.5 bu.	221	1625
Total		948	9930					
Total less stover		843	7624		Total		878	5091

The Livestock rotation so far has given the larger yields of crops and of digestible nutrients. It is assumed that the corn stover would have been used for feed. (If the corn crop had been harvested for silage, a yield of approximately 12 tons per acre would have been obtained which would have had about the same feeding value as indicated for the corn grain and stover.) If the stover is not fed, then the Grain rotation is slightly ahead in digestible protein but not in total digestible nutrients (T. D. N.).

Soybean grain is a very high producer of digestible protein per acre.

L. E. Thatcher

ROTATIONS AFFECT SOIL STRUCTURE AND CROP YIELDS

In the project on soil structure, a number of rotations were started on fairly uniform, productive soil at the Paulding County Experiment Farm in 1936. In the 9 years since that time, these rotations have produced great differences in the structure of the soil, which is clearly one important factor in the yield of corn and other crops. The following tabulation gives the rotations and the average yields of unfertilized corn for the 6 years 1939-1944.

Rotation	Yield of corn
	Bu.
Corn, oats, alfalfa-bromegrass 2 years	69.0
Corn, oats, sweetclover	65.3
Corn, oats, alfalfa 2 years	65.1
Corn, oats, alfalfa	59.8
Corn-soybeans-oats (sweetclover)	57.4
Corn-oats (sweetclover)	56.2
Corn-oats	50.8
Corn-oats (residues removed)	37.8
Corn continuously, residues returned	25.8
Corn continuously, residues removed	28.1

At the Paulding Farm commercial fertilizers have consistently given very low returns because the physical condition of the soil has always been the limiting factor. Half of each plot in this experiment has been fertilized since 1941. Fertilizer has increased the yields of the better plots more than those of the poorest plots. This shows that the poor physical conditions induced by frequent plowing and lack of structure-building sod crops have been the limiting factors in the corn yields.

The differences between the better and the poorer plots have continually increased. In 1943, for example, the yield from the corn-oats-2 years alfalfa-bromegrass rotation had increased from the original 42.4 bushels to 78.2 bushels, compared with a decrease from 42.2 to 19.0 bushels for the continuous corn plot.

The differences in physical properties of soils from the different rotations have been evident both in laboratory measurements and to direct observation, particularly in the workability and drainability (fig. 6) of the plots. Rotations on heavy soils must include more deep-rooted legumes in longer rotations if profitable crop production is to be maintained.

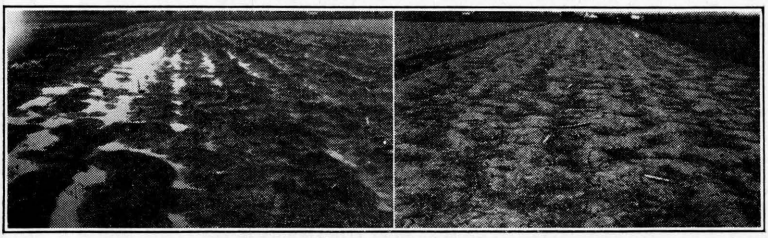


Fig. 6.—Continuous corn puddles heavy soils. Paulding County Experiment Farm. May 10, 1944. Soil structure rotation. *Left*, plot continuously in corn since 1936. *Right*, plot in rotation of corn-oats with a sweetclover catch crop since 1936. Both plots plowed for corn on same date.

J. B. Page, C. J. Willard, and R. E. Yoder

EFFECT OF COMPACTION OF SOIL ON EMERGENCE OF LEGUME SEEDLINGS

In a study of some of the factors which affect the establishment of pastures and meadows, experiments were conducted to determine the effect of soil compaction on seedling emergence. Four different soils, representing three types, were tested at different moisture contents and degrees of compaction. The degrees of compaction were 2, 4, and 8 pounds per square inch, while the moisture content of the soils ranged from about the wilting point to approximately 8 per cent above.

Results show that the soil type is more critical than the degree of compaction. Compaction of the soil below the seed usually resulted in an earlier emergence of the seedling than compaction above the seed. This is especially important when weather conditions are such that rapid drying of the surface occurs. Results of compaction both below and above the seed fluctuated. Compaction of any type produced earlier emergence of the seedlings than no compaction, particularly at the lower soil-moisture contents.

J. C. Carroll

THE EFFECT OF SOYBEANS IN CROP ROTATIONS

Soybeans harvested (1) for hay, (2) for grain with the combine harvester, and (3) with a grain binder and threshed with a grain separator have been grown in a 4-year rotation of corn, soybeans, wheat, and clover hay in the Fry Farm Crop Rotation Experiment at Wooster. A large number of other crop rotations without soybeans are also carried on with which the soybean rotations may be compared.

The largest average yield of wheat in the soybean rotations was that following soybean hay. Soybean hay favors the wheat largely because the soybean hay is harvested early in September; thus, the soybean roots and stubble and other residues begin to decay at once and so release their fertility elements in available forms for the use of the young wheat seedlings. On the other hand, the lowest yield of clover hay in any of the soybean rotations was obtained in the soybean hay rotation. The reasons for this are not clear, but the large removal of phosphate and potash by the soybean hay crop may be a factor. The corn yields were also slightly the lowest in the soybean hay rotations.

The largest yields of corn and clover were obtained in the combine-harvested soybean grain rotation and the yield of wheat was somewhat better than where the soybeans were binder harvested. In preparing the seedbed for wheat, the soybean haulm was disked lightly and much of it remained near or on the surface. Apparently this soybean haulm had sufficient mulching effect to favor a good stand of clover seeded in the wheat. The higher yield of corn probably resulted in part from the better clover sod obtained and also from the additional organic matter furnished by the soybean haulm.

Harvesting soybeans with a binder and removing the haulm from the land produced the lowest yield of wheat and next to the lowest yields of corn and clover.

All of the soybean rotations produced 20 to 40 per cent more digestible protein per acre than was produced in the common 4-year rotation of corn, oats, wheat, and clover. They also produced a little more total digestible nutrients. However, a 4-year rotation of corn, wheat, and 2 years of alfalfa hay produced annually 112 pounds more digestible protein than the best of the soybean rotations, or an increase of 74 per cent. (The alfalfa rotation produced about twice as much digestible protein per acre as the corn, oats, wheat, clover rotation.)

L. E. Thatcher

MOBILITY OF POTASSIUM WHEN ADDED AS A POTASH FERTILIZER ON A STRAW MULCH

A potash fertilizer placed on soil maintained in a sod or cultivated system of culture is relatively immobile. It is not readily leached into the soil mass as is a nitrogen fertilizer, such as nitrate of soda. In fruit-growing areas where a lack of potassium might be experienced, a method whereby available potassium could be supplied and kept in an available state would be advantageous.

Experiments conducted at Wooster indicate that this can be accomplished most effectively by mulching with unweathered material such as straw or hay. If a greater increase is desired, additional potassium can be added directly to the mulch as a potash fertilizer (Fig. 7).

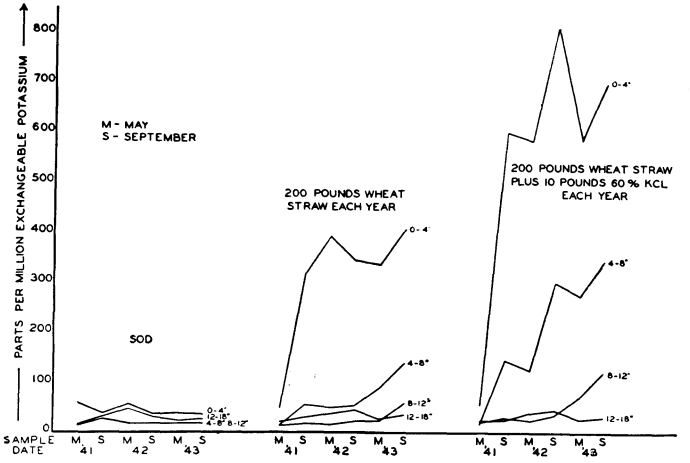


Fig. 7.—Amounts of available potassium in the soil after a period of 3 years under sod, mulch, and mulch with added potash fertilizer

Potassium thus supplied to the soil will not be rendered unavailable as readily because of the conditions prevailing under a mulch.

J. H. Gourley and I. W. Wander

COMBINED WHEAT STRAW MAY INJURE MEADOW SEEDINGS

The advent of the combine harvester, which leaves small-grain straw on the ground, has resulted in unexpected effects of this straw on the meadow seeding, as well as in difficulties in obtaining sufficient straw for bedding on livestock farms.

Accumulated experience and evidence indicate that combined straw left on the field sometimes does no harm to clover and alfalfa seedings, but more frequently it may seriously reduce the stands and the yield of the legumes.

A wheat field combined on August 10, 1943 at Columbus was treated in four ways

1. As the combine left it;
2. Combined straw raked at once and removed;
3. Stubble clipped, straw left;
4. Stubble clipped and removed.

As in all previous years, clipping and removing all straw and growth gave the largest yield of the cleanest alfalfa-clover-timothy hay—2930 pounds per acre of hay containing only 0.4 per cent of straw.

Leaving the straw resulted in serious injury to the stand (fig. 8) and in a yield of 2100 pounds of hay containing 13.2 per cent of straw, or 1820 pounds of clean hay per acre; that is, 38 per cent less than where the clipped stubble was removed.

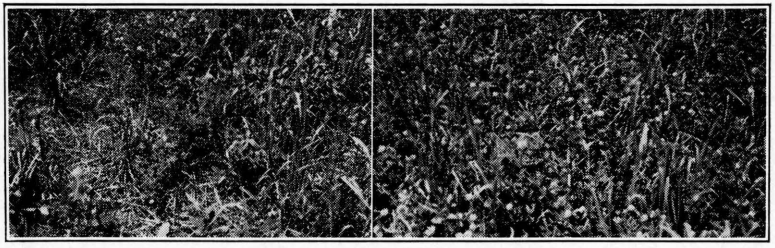


Fig. 8.—Heavy combined straw injures seedings. Columbus, June 4, 1944. *Left*, straw not removed, stubble not clipped, after combining wheat in 1943. *Right*, stubble cut and everything removed at once after combining. The two areas are in the same drill row, and less than 10 feet apart.

Raking the combined straw gave as good stands and yield as clipping the stubble, but the hay contained 2.7 per cent of cut stubble.

Leaving the clipped stubble on the ground caused much less injury than not clipping and a yield of 2730 pounds per acre of hay containing 5 per cent of straw, or 2590 pounds of clean hay, resulted. Usually there is not this much straw in the hay from early-clipped fields, but because the fall and winter of 1943-44 were dry, the straw did not decay as rapidly as usual.

Combined straw should be raked, or the field should be clipped and the straw removed at once after combining. The clipping should be *as low as the mower will cut.* To cut high is to favor weeds (which start new growth only from buds along the stem) over alfalfa, clover, and timothy (which start from the crown, whatever the height of cutting). Sweetclover seedings, however, *should never be clipped.*

TABLE 4.—Effect of treatment of combined wheat straw on following hay crops

	Yield per acre, as raked	Straw in hay as raked	Yield per acre clean hay	Yield as per cent of plots 3, 5, 8, 10
	Lb.	*Pct.*	*Lb.*	
Plots 1, 6. Nothing done after combining	2100	13.2	1820	62
Plots 2, 7. Combined straw raked August 15 and removed	3000	2.7	2920	100
Plots 4, 9. Stubble clipped August 15, and straw and stubble left on ground	2730	5.0	2590	88
Plots 3, 5, 8, 10. Stubble clipped August 15, all material removed	2940	.4	2930	100

C. J. Willard and R. D. Lewis

SWEETCLOVER IN WARTIME CROP ROTATIONS

Ohio soils have gone to war. Larger and larger proportions of Ohio crop land are in soil-depleting grain and cultivated crops, and smaller and smaller proportions are in the soil-regenerating crops.

Rotation experiments with a sweetclover catch crop point the way to raise grain every year and still almost maintain soil productivity. Experiments comparing the 2-year rotation of small grain one year, corn the next, without a clover catch crop, with the same rotation with a sweetclover catch crop sown in the small grain and plowed down for corn have been conducted at the Northwestern and Southwestern Experiment Farms.

On Miami silty clay loam at the Southwestern Experiment Farm, one crop of sweetclover plowed under increased the yield of corn 18.6 bushels per acre.

On Brookston clay at the Northwestern Experiment Farm, plots in this 2-year rotation have been continued with and without sweetclover since 1930. For the last 7 years of the test, the plots with sweetclover plowed down May 1 have averaged 20.1 bushels more corn per acre than the plots without sweetclover—and the oats averaged 7 bushels more each year in the same period.

TABLE 5.—Sweetclover for green manure

Plot and treatment	Fertilizer or manure	Yield per acre					
		Corn		Oats		Oats straw	
		Bu.	Bu.	Bu.	Bu.	Lb.	Lb.
Southwestern Experiment Farm							
Uniform fertilizer applications—250 lb. of 0-12-12 on corn and oats.		1944	1942-1944	1944	1943-1944	1944	
1. No sweetclover: straw and stover removed		28.2	51.1	33.3	37.5	1060	.....
2. No sweetclover: straw and stover plowed down		30.0	52.1	31.9	39.0	1060	.....
3. Sweetclover in oats for corn		30.8	60.8	38.0	43.6	1160	.....
4. Like 3, straw also plowed down		32.5	64.1	38.9	43.8	1110	.....
5. Like 3, stover also plowed down		31.2	62.3	42.7	44.6	1160	.....
6. Like 3, straw and stover plowed down		34.5	63.6	42.7	46.2	1110	....
Average plots 3, 4, 5, 6		32.2	62.7	40.6	44.6	1140	.....
Average plots 1 and 2		29.1	51.6	32.6	38.2	1060	.....
Gain for sweetclover		3.1	11.1	8.0	6.4	80	.....
Northwestern Experiment Farm							
Legume / Date plowed		1944	1938-1944	1944	1938-1944	1944	1940-1944
1. None / May 1	0-14-6	43.6	39.8	39.1	38.5	3170	2220
2. Sweetclover / May 1	0-14-6	59.8	61.6	47.4	45.4	4770	3500
3. None / May 15	0-14-6	46.1	42.6	35.7	39.3	3270	2350
4. Sweetclover / May 15	0-14-6	51.8	54.6	50.1	45.1	4670	3130
5. None / May 1	0-14-6	46.8	42.1	38.2	40.5	3830	2350
6. Sweetclover / May 1	0-14-6	59.1	60.5	48.4	47.5	4470	3410
7. None / May 1	Manure and 0-14-6	60.7	51.9	44.9	47.9	4400	2900
8. Mammoth clover / May 1	0-14-6	66.9	55.3	43.8	47.4	4370	2690
9. Sweetclover / May 1	0-20-0	54.4	56.3	43.8	44.8	4400	3330
10. Sweetclover / May 1	Rock phos.-KCl	51.2	57.1	43.6	45.5	4200	3180
11. Sweetclover / Nov. 1	0-14-6	58.5	56.8	48.5	44.6	3970	3160
Average plots 2, 4, 6	.....	56.9	58.9	48.6	46.0	4640	3350
Average plots 1, 3, 5	.....	45.5	41.5	37.7	39.4	3420	2340
Gain for sweetclover	.....	11.4	17.4	10.9	6.6	1220	1010

This rotation will not quite maintain soil productivity. However, for the same 7 years at the Northwestern Experiment Farm, the yields of corn and oats in a 4-year rotation of corn-oats-alfalfa-wheat with a sweetclover catch crop were almost identical with those in the 2-year sweetclover rotation. In view of wartime needs for food and feed, this 2-year rotation with sweetclover, which permits every acre to raise more grain every year and still almost maintain soil productivity, should be more widely used.

At the Northwestern Experiment Farm in the rotation series on ranges 1, 2, 3, and 4, the yields of corn and oats on plots 4 and 8, (which have been in the rotation corn-oats-alfalfa-wheat with sweetclover catch crop since 1929) were as follows for 1938-44:

	Plot 4	Plot 8	Average
	Bu.	*Bu.*	*Bu.*
Corn	58.7	56.0	57.4
Oats	47.8	49.5	48.6

C. J. Willard

LIMESTONE EVALUATION CHART

Agricultural liming materials are offered in various grades and at different prices. Sellers in Ohio are required to furnish a chemical analysis showing guaranteed percentages of calcium and magnesium and of the total neutralizing power in terms of equivalent per cent of calcium carbonate, as well as a fineness analysis showing the percentages passing numbers 8, 20, 60, and 100 standard sieves. These data are sufficient for an evaluation, if one is given the additional factors of time of action and the cost per ton applied to the field. Nevertheless, the problem is too complicated for a satisfactory treatment by ordinary means; a practical comparison of costs of active lime supplied by different materials is desired. An alinement chart has recently been devised to simplify the solution. The sieve data are spotted thereon, and a fineness line is drawn best to fit these points; then, at its intersections with lines printed on the chart, corresponding to the probable activities of pure limestone minerals in Ohio soils over different periods, values are read. A further multiplication by a factor derived from the total neutralizing power is all that is necessary to indicate the activity of an impure limestone or one of character intermediate between a high calcium and a dolomitic limestone; from this the cost per ton of

active lime in the material is easily computed. The chart also shows the average size composition of the several grades of agricultural limestone marketed and brings before the eye all at once the relation between fineness, chemical composition, time of action, and activity of agricultural limestone. The printed chart with mimeographed instructions and detailed examples comparing limestone and other liming materials, such as hydrates, has been prepared for distribution.

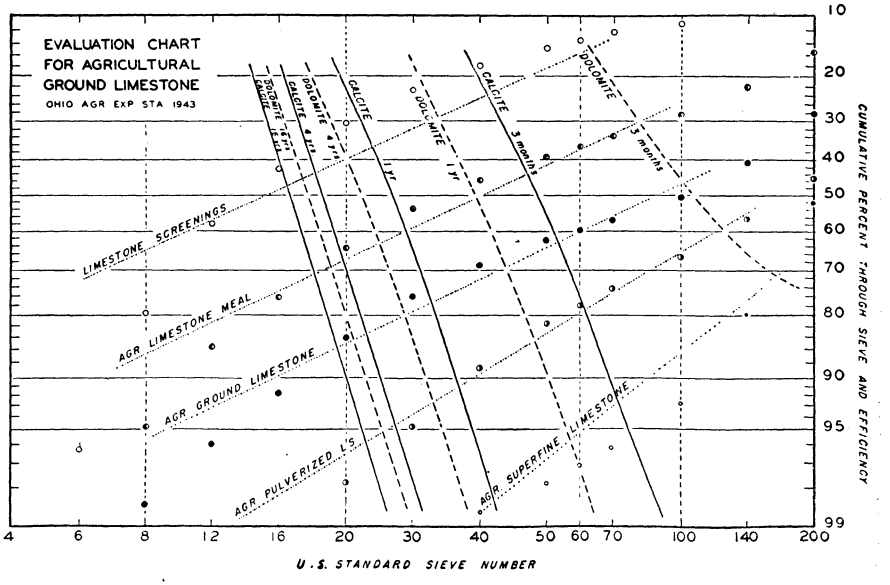


Fig. 9.—Limestone evaluation chart

C. J. Schollenberger

Pasture and Hay

ALFALFA VARIETIES AND STRAINS TESTED IN MIXTURE WITH TIMOTHY

Nineteen strains and varieties of alfalfa, each grown in mixture with timothy, have been compared for 4 years at Wooster. The alfalfa represented strains well-adapted and poorly-adapted to Ohio; seed was obtained from a number of sources from Ontario, Canada, to Texas and from Ohio to Washington and Oregon.

It was found that the proportion of alfalfa and timothy in the hay (first cutting of each season) varied with the yield of the alfalfa part of the mixture. The stand of alfalfa became thinner as it became older in proportion to its adaptation to the local environment. Some of the non-hardy strains from Arizona had lost over one-half of the original stand in 4 years; whereas, the stand of the well-adapted strains from seed produced in Ohio or other favorable sections of the country was still good. As the stand and yield of alfalfa became less, the yield of the timothy became larger, compensating to a large degree for the loss in the yield of the alfalfa hay (but not, of course, in the loss in feeding value per ton).

When the varieties of alfalfa were lined up in the order of the yields of the alfalfa fraction of the mixture from the highest to the lowest and the yield of the timothy fraction of each mixture placed opposite, it was plain to see that as the yields of alfalfa decreased the yields of the timothy increased. The relationship may be stated as follows: For each 500 pounds decrease in the yield of the alfalfa fraction in 1941 there was an increase of 230 pounds in the yield of the timothy fraction. Likewise, for 1942, the increase was 580 pounds; in 1943, it was 540 pounds; and in 1944, it was 600 pounds.

A practical lesson from this experiment is that when a poorly-adapted variety of alfalfa is sown, or where alfalfa is sown on a soil not too well suited to its survival, some timothy sown with it will help to maintain the yield of mixed hay. Without the timothy, the hay would soon become weedy and of lowered feeding value. It is better to have timothy than weeds in the hay.

Alfalfa-timothy or alfalfa-clover-timothy mixtures should replace a large part of the clover, clover-timothy or straight timothy now sown in Ohio.

L. E. Thatcher

NEW WILT-RESISTANT ALFALFAS MAKE GOOD RECORD

Alfalfa wilt is becoming an increasingly serious problem to alfalfa growers in the more important alfalfa-producing areas of Ohio. A cooperative alfalfa breeding and testing program between the Bureau of Plant Industry, Soils, and Agricultural Engineering of the U. S. Department of Agriculture and several State Experiment Stations, including Ohio, has resulted in the production of two important new wilt-resistant alfalfas—Ranger, developed mainly at the Nebraska Station, and Buffalo, developed at the Kansas Station. Since 1940, 32 tests comparing these alfalfas with standard varieties have been sown at Columbus, Wooster, and the outlying Experiment Farms of the State.

As an average of six of these tests, Ranger in the first hay year yielded 94 per cent as much as the average of the adapted variegated alfalfas, and Buffalo, in five tests, yielded 93 per cent. These are good records, since the wilt-resistant varieties formerly available were comparatively poor yielders when wilt was not present.

Wilt has developed most severely in a test at Columbus. Here, in the first hay year, Ranger and Buffalo each made yields identical with the average of six high-yielding variegated alfalfas—3.06 tons per acre in two cuttings. In the third hay year, 1944, following the development of severe wilt damage in 1943, the same six variegated alfalfas averaged 1.64 tons per acre in two cuttings, ranging from 1.12 tons to 2.29 tons, while Buffalo averaged 3.02 tons and Ranger, 2.79 tons. Furthermore, Buffalo and Ranger will make good yields in 1945, but the variegated alfalfas are not worth leaving.

"What Alfalfa for 1945" in Bimonthly Bulletin No. 231 for November-December 1944 gives a more complete account of these tests of alfalfa varieties.

C. J. Willard and R. D. Lewis

BETTER STRAINS OF BROMEGRASS

Studies of many legume-grass mixtures have shown that bromegrass-alfalfa mixtures are high-yielding and long-lived. Most of these experiments have used Canadian bromegrass. Recent tests comparing different strains and sources of bromegrass show that old strains of bromegrass from Kansas, Nebraska, and Iowa are definitely superior to those from the north.

In the comparisons at five locations, Columbus, Mt. Healthy, Batavia, Holgate, and St. Clairsville, the Achenbach strain from Kansas outyielded Canadian bromegrass in 1943 by 850 pounds of cured hay per acre, or 18 per cent, and in 1944 by 1560 pounds, or 28 per cent. (Figure 10).

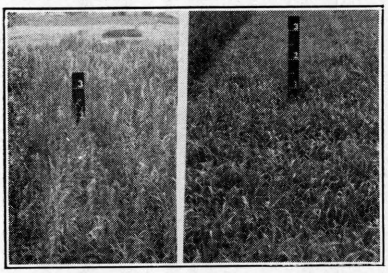


Fig. 10.—Adapted bromegrass outyields Canadian. Columbus, May 1944. Bromegrass strains sown early September, 1943. *Left*, Lincoln. *Right*, Canadian.

At least one factor in this superiority is that the Kansas bromegrass is adapted to the day length of the 40° parallel. There are several of these "southern" bromegrasses—Achenbach from Kansas, Lincoln from Nebraska, Fisher from Iowa, and MI-26-26 from Missouri. Additional tests will be required to evaluate these strains. All are superior to Canadian or northern U. S. seed.

C. J. Willard and J. W. Lambert

CUMBERLAND CLOVER OUTSTANDING FOR SOUTHERN OHIO

Tests at Columbus, Wooster, and several of the Experiment Farms in southern Ohio had previously shown that Cumberland, or any of its three component strains, were definitely superior in southern Ohio to commercial red clover seed and even to known strains from northern Ohio or from farther north and west.

In 1943 excellent stands of each of 15 different strains or sources of red clover were obtained at Columbus. Nevertheless, by August 25, over 50 per cent of the plants of some strains had died. The next spring, after no winter injury either by cold or heaving, the plots of Cumberland could be identified, even from a distance, by their thickness of stand and vigor of growth. In two cuttings in the dry season of 1944 Cumberland yielded 2 tons of hay per acre, while northern Ohio strains yielded from 1 to 1½ tons, and seed from Oregon and Minnesota yielded less than ½ ton. These striking differences were probably due to the greater resistance of Cumberland to diseases which attack red clover often but in variable severity throughout the southern one-third to one-half of Ohio.

R. D. Lewis and C. J. Willard

HOT-WEATHER LEGUMES IN PERMANENT PASTURES

One of the greatest difficulties in securing adequate production in permanent pastures in Ohio is the maintenance of a satisfactory legume content. The legume is needed because of its high protein and lime content and for the nitrogen which it makes available for the growth of associated grasses. The presence of the legume may also increase the protein content of the associated grass by 50 per cent.

White clover has been the chief legume of permanent pasture areas, but even with adequate lime and fertilizer treatments it has fluctuated greatly with weather conditions, frequently disappearing completely with hot, dry weather.

During the past 2 years the Department of Agronomy has been attempting to determine (a) what legumes would withstand the hot, dry weather best and would persist longest under the rather severe grazing condition to which permanent pastures are subjected, and (b) what seedbed preparation and soil treatment are necessary to the establishment and maintenance of these legumes.

No legume has been found that would make a satisfactory growth on depleted pasture land without treatment. Of those tried, Korean lespedeza has made the best showing under this unfavorable condition, but its yield was more than doubled by lime and fertilizer.

On treated areas Ladino and Louisiana white clover, Korean lespedeza, and birdsfoot trefoil (*Lotus corniculatus*) have made the best showing. Others tried were hop clover, strawberry clover, swamp-horn clover (*Lotus uliginosis*), and, in a few tests, other varieties of lespedeza. Seeding these on treated land but without seedbed preparation has resulted in failure 75 per cent of the time.

Where soil treatment and soil preparation both preceded seeding, a high degree of success in establishment was obtained with Ladino and Louisiana white clover, the corniculatus variety of birdsfoot trefoil, and Korean lespedeza. This is indicated in the summary of 60 tests (table 6).

TABLE 6.—The per cent of trials producing good stands of the various legumes indicated when seeded in permanent pastures under the soil treatments specified

Legume	Per cent of trials producing good stands		
	Disked only	Limed and fertilized only	Disked, limed, and fertilized
Ladino clover	10	23	41
Louisiana white	10	23	41
Birdsfoot trefoil	6	15	25
Korean lespedeza	9	21	35

The tests have not been in progress long enough to determine definitely the drouth tolerance of the various legumes, but birdsfoot trefoil (*Lotus corniculatus*) appears to have some promise in this respect.

D. R. Dodd

PASTURE FARM STUDIES

The results obtained on the pasture farm during the dry season of 1944 showed that it paid to supplement bluegrass pasture with hay feeding in the barn. The cows that received hay in addition to the bluegrass pasture averaged 32.3 pounds of 4 per cent milk daily; whereas a similar group grazing these same pastures but receiving no additional hay averaged only 22.0 pounds of 4 per cent milk. A third group of cows that grazed alfalfa-timothy meadows averaged for the period 30.0 pounds of 4 per cent milk daily. The period covered in this comparison was from May 24 to October 12, 1944, or 142 days.

During this pasture period all the cows were given as much grain as they cared to eat, up to a 1 to 4 ratio. The group on bluegrass produced 3.96 pounds of milk for each pound of grain; the group receiving hay, 4.22 pounds; and the group on legume pastures, 4.89 pounds. This latter group refused the largest amount of grain. The cows receiving the hay, ate on the average, 3.6 pounds of hay per day.

This represents the season's performance of the three groups and includes a 2-week period, from August 12 to 26, when the bluegrass cows were on a second-growth alfalfa-orchard grass field because of the scarcity of grazing on the bluegrass fields. Such a procedure of supplementing the midsummer grazing with meadow-crop aftermath is frequently followed on farms where the chief dependence is placed on permanent pastures.

TABLE 7.—Returns per acre from rotated bluegrass, rotated alfalfa-timothy, and alfalfa-timothy pastured and made into hay

	Returns per acre				Feed consumption	
	Hay	Cow days	4% milk	Gain or loss in weight	Grain	Hay
	Tons	*No.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Permanent, improved bluegrass, four 4-acre fields, rotated	.....	127*	3564.8	+ 9	802	156
Alfalfa-timothy (grazed entirely), 3 acres, rotated	.....	161	4844.0	—33	945	.....
Alfalfa-timothy, 6 acres, hay and pasture	2.36	58	1797.0	+68	358	.....

*Plus 16 heifer-days.

Pasture Yields

The yields of the two chief pastures are shown in table 7. In this table the entire grazing of the fields is considered. This extended from April 26 to October 23.

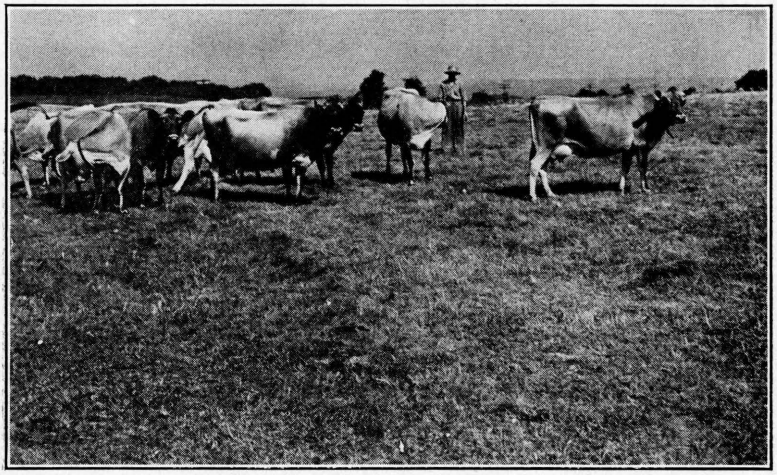


Fig. 11.—Cows on improved bluegrass pasture, August 2. Part of these cows received additional hay in the barn and maintained a higher production than those cows not receiving hay.

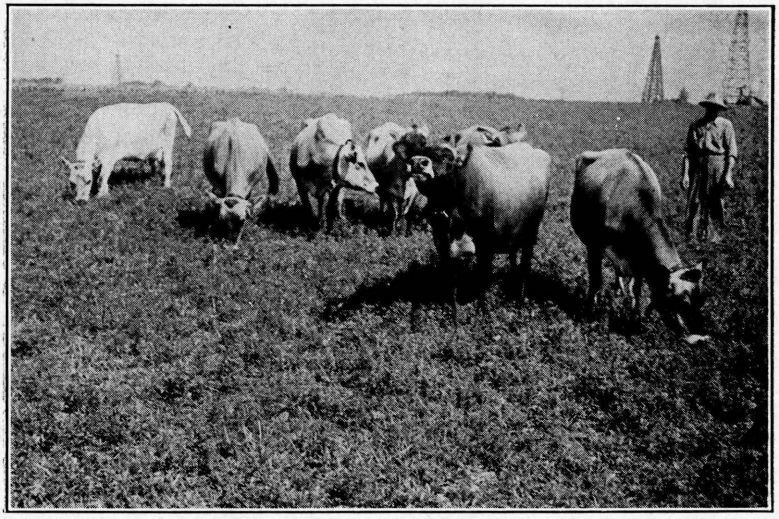


Fig. 12.—Cows on a second-growth alfalfa-timothy meadow, August 2. These cows maintained a satisfactory production on legume-timothy meadows throughout the season. The first cutting from the above field averaged 2.36 tons per acre.

C. F. Monroe

SAVING GRAIN

Good breeding plus liberal supplies of pasture and hay from clover-alfalfa-Ladino-timothy rotation meadows at the TRUMBULL COUNTY EXPERIMENT FARM have made it possible to decrease quite markedly the amount of grain fed to the Holstein herd. This is secured by feeding less grain during a little more than two-thirds of the year and none throughout the remaining time. Grain feeding stops when the flow of milk gets down to 20 pounds per day and is not again started until the next freshening period. Even then, when a cow freshens on very luxuriant pasture and shows signs of going very much above 70 pounds of milk per day, grain is withheld or fed sparingly rather than go to the bother of milking three times per day. Cooperation through artificial insemination rings rapidly is providing the means of improved breeding, and dairyman individually can provide the hay and pasture, thus making possible the pay-off in reduced grain requirements.

M. A. Bachtell, C. F. Monroe, and Walter Livezey

WHITE GRUB INVESTIGATIONS—1943

White-grub population records taken in experimental pasture fields in 1943 revealed that grubs were abundant in permanent pastures and not in rotated pastures. In the permanent bluegrass pastures the grub populations were highest in unfertilized fields where the bluegrass cover was thin or was partly replaced by other grasses and weeds. In fields where applications of 400 pounds of 0-14-6 fertilizer and 4 to 5 tons of manure per acre were made alternately at intervals of 2 years (each material every fourth year) the grub population was reduced 63.3 per cent as compared with similar unfertilized fields. In fields where an annual spring application of 200 pounds per acre of sulfate of ammonia was added to the foregoing manure and fertilizer treatment the grub population was reduced 86.5 per cent from that in the untreated fields. These differences were probably due to the variations in the quality and quantity of grass that resulted from the fertilizer and manure applications. Of the 1,086 grubs taken in these samplings, 59.3 per cent were *Phyllophaga* spp.; 36.6 per cent, *Cyclocephala borealis* Arrow; 2.4 per cent, *Cotinis nitida* (L.); 1.6 per cent, *Anomala innuba* (F.); and 0.6 per cent, *Macrodactylus subspinosus* (Fabr.).

In a study of white-grub survival on different pasture-crop plants, pure stands of nine different pasture crops were grown in enclosed areas of approximately 2⅕ square feet and were infested with *Phyllophaga* grubs by caging equal numbers of pairs of known species of May beetles over each enclosed area. Each treatment was replicated five times. In the fall, the average grub population per plot in the entire experiment was 28.4. The two lowest mean grub populations were 6.0 for alfalfa and 7.6 for sweetclover. The two highest were 59.4 for bromegrass and 54.2 for orchard grass. It was thought, however, that differences in the physical condition of the soil resulting from differences in the moisture requirements of the various crops, rather than the food itself, were responsible for much of the variation in grub population.

(See *also* Turf and Ornamentals)

C. R. Neiswander

Silage

ALFALFA-CHEAT SILAGE

It wasn't planned that way, but it so worked out that for 2 successive years the silo at the BELMONT COUNTY EXPERIMENT FARM has been filled quite largely with a cheat-legume mixture. In 1942 two medium-sized areas were summer seeded to timothy, alfalfa, and Ladino clover by the trash-mulch method. On one area which had been in alfalfa-timothy meadow for several years a splendid catch of grass later proved to be cheat. In 1943 there was a heavy yield of alfalfa-cheat, which was put into the silo. No comparisons were possible during the winter months, but near the end of the barn period the alfalfa-cheat silage gave out and the remainder of the time the cows were given corn silage from the bottom of the silo which was a carry over from the previous year. No change in quantity of material eaten or milk produced was noticed. In 1944 the other area had developed into a Ladino-cheat mixture and this also was ensiled with very creditable results.

M. A. Bachtell and Henry McMahon

CORN SILAGE

Quality in Corn Silage

In order better to evaluate the suitability of different varieties of corn for silage, several varieties of open-pollinated and hybrid corn have been cut at the ensiling stage and then divided into their component parts. The amounts of each part have been ascertained along with the total acre yield. Analyses have been made on the parts for some of the varieties.

A sample of the separation of a single-cross hybrid (4-8 × 40 B) into its component parts is shown here.

Ears		54.3
Grain	41.2	
Cob	13.1	
Leaves		10.9
Husks		9.3
Sheath		5.4
Stalk		20.1
		100.0

The high percentage of total dry weight in the ears is a desirable characteristic of good corn silage, as is the low percentage of stalks.

The aim in making corn silage is to produce a feed high in total digestible nutrients. Fortunately, there are hybrid varieties that yield well and that also give good quality silage, as indicated by the above standards.

C. F. Monroe, W. E. Krauss, A. E. Perkins, and C. C. Hayden

Corn Silage from L 94 Versus that from U. S. 13

Silages from two varieties of hybrid corn, L 94 and U. S. 13, were compared in feeding trials with milking cows and growing heifers. The corn was all grown in the same field under similar cultural conditions and harvested at about the same time—near the middle of September. Due to a late season, both varieties were still high in moisture when ensiled and thus resulted in silages of 77.4 and 75.6 per cent moisture for the L 94 and U. S. 13, respectively. With this exception in moisture content and that of the carotenoid content, the two silages were very similar. Both were readily eaten in maximum quantities. The carotene (total carotenoids) in the L 94 silage averaged 97.6 gamma per gram, on a dry basis; whereas that of the U. S. 13 averaged 68.2 gamma.

In the feeding trials with both milking cows and growing heifers, grain and hay were fed rather sparingly, but the silage was fed liberally in order to give a more drastic comparison between the two silages. The plan called for an equalized dry-matter intake of the two silages, as well as for the grain and hay.

The production of the milking cows was practically the same on the two silages, with an average production per 30 days per cow of 759.7 pounds of 4 per cent milk on the L 94 silage and 766.3 pounds on the U. S. 13 silage.

There was an average loss in liveweight for the 30-day period of 8 pounds per cow on the L 94 silage and a gain of 16 pounds on the U. S. 13 silage.

The carotene and vitamin A content was very slightly higher in the milk produced on the L 94 silage.

The average liveweight gain per month of the heifers was 51.3 pounds on the L 94 and 42.2 pounds on the U. S. 13. This difference appeared in the Holstein heifers; the Jerseys gained practically the same on each silage.

Since L 94, a new hybrid, was found to compare favorably with U. S. 13, an accepted variety, its suitability as a silage crop for dairy animals was indicated.

C. F. Monroe, W. E. Krauss, A. E. Perkins, J. W. Hibbs, C. E. Knoop, and C. C. Hayden

MEADOW-CROP SILAGE

Work with meadow-crop silage involves so many aspects that personnel trained in various fields must cooperate in solving the many problems presented. To accomplish this a single comprehensive project was developed employing personnel from the following departments: Agricultural Economics, Agricultural Engineering, Agronomy, Animal Industry, Botany and Plant Pathology, and Dairy Industry. Progress of work falling within the scope of this project is reported in this section. Other work involving meadow-crop silage will be found under *Livestock and Poultry*.

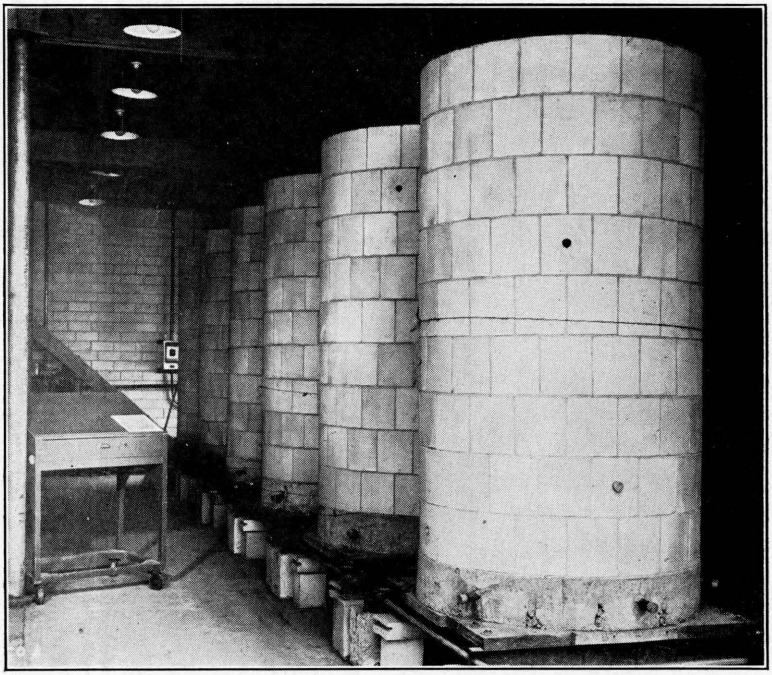


Fig. 13.—Series of tile Pilot Silos in silo building

Special Equipment

To study the fundamental factors in silage formation, as well as to test recipes of mixed crops, added preservatives, and crop conditioning, a large number of tests were outlined requiring containers of 2000-pound capacity or less. For that reason, there are now in a special building four series of Pilot Silos of the four basic materials used for silo construction—concrete stave, steel, tile, and wood. The Pilot Silos are approximately 3.5 feet by 7 feet, arranged in rows in the silo building to permit easy filling from above. The building is designed to protect the silos and to maintain them under relatively uniform conditions.

Figure 13 shows the series of tile silos in the silo building.

C. F. Rogers

Special Machinery

It was evident at the beginning of this project that in order to make grass silage efficiently, the machinery problem should be studied.

Experimental machinery was supplied by the Allis-Chalmers Manufacturing Company and at the end of each year's work the equipment was returned to the factory so that changes and improvements based upon the findings of the season's work could be made.

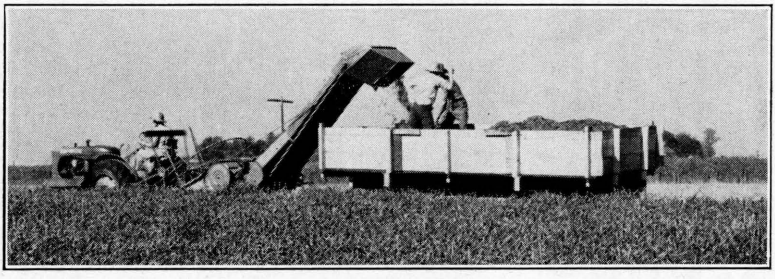


Fig. 14.—Forage harvester

The equipment was designed so that grass silage could be made by either cutting the standing crop or by picking up a partially cured windrow. The machine operated very successfully during the season of 1944. The field cutter was readily adapted to the making of corn silage by replacing the grass attachment with a corn attachment.

The addition of dry-matter material to the crops cut standing was made possible through an attachment on the blower which was used to elevate the grass silage into the silo. This was a metering device which regulated the flow of a predetermined quantity of corn meal into the silage as it was being blown into the silo.

The amount of corn meal was automatically varied according to the volume of silage delivered to the fan of the blower. This amount could be varied to balance the dry-matter content of the grass for satisfactory preservation.

The chief obstacle of the mechanical phase was the unloading of the chopped silage from the wagon to the blower. Too much hand labor was required, and steps should be taken to mechanize this phase of the work.

G. W. McCuen

Density Studies

Silage densities are useful in computing the quantities of silage remaining in silos.

In farm silos the silage density increases with depth and varies with the nature and dry-matter content of the crop. Silages of low dry-matter content have higher densities, and usually a higher dry-matter density as well, than do the high dry-matter silages in the same sized silos. In a 10-foot by 32-foot silo filled with spring-grown grass, the finished silage was about 27 feet deep. Its density ranged from 16 to 50 pounds per cubic foot in a depth difference of 25 feet.

TABLE 8.—Densities of silages

Depth from top of silage	Low dry matter 19.2 %	Medium dry matter, 23.6 %
Feet	*Lb./Cu. ft.*	*Lb./Cu. ft.*
0 -0.7	30.8	31.1
0.7-1.7	42.6	42.1
1.7-2.6	42.0	41.2
2.6-3.8	46.5	69.0

Depth from top of silage	High dry matter 45.0 %
Feet	
0 -1.3	27.9
1.3-1.6	37.1
1.6-4.3	19.1
4.3-6.6	23.7

Silage densities in the Pilot Silos, described at the first of this section, varied as much as in farm silos. The low dry-matter silages tended to increase in density with depth, but those of medium

and high dry-matter did not show consistent variation with depth. Differences in tramping could account for some of the variations. Examples of relation of silage density and depth to dry-matter content are shown in table 8.

C. F. Rogers and W. A. Junnila

Do Repeated Handlings of the Chopped Crop Affect Silage Quality?

Preliminary tests of silage made in small containers from chopped crops taken directly from the cutter in the field and from the silo after the same load had stood 2½ hours over the noon hour before being blown into the silo showed that there was no detectable difference in silage quality as measured by pH, total acidity, amino-nitrogen, and animal preference.

It has been shown that, when crops are brought quickly to a fixed density of 35 pounds per cubic feet in small containers and held from one week to 6 weeks at room temperature, good silages result.

C. F. Rogers and W. A. Junnila

The Performance of the "Silage Carburetor"

As a test of the effectiveness of the "silage carburetor" three different meadow crops received varying quantities of ground ear corn.

Dry-matter measurements of the crop as cut and again after additions by the carburetor of from 53 to 175 pounds of ground ear corn per ton of chopped crop showed that, although the settings of this particular machine might not deliver as much dry material as expected, it distributed the ground ear corn with a high degree of uniformity and that it was able to distribute 53 pounds of corn meal as evenly through a ton of chopped crop as it could mix 150 to 175 pounds per ton.

C. F. Rogers

Chemical Studies

GENERAL

Chemical determinations regularly made have been dry matter, pH, carotene, titratable acidity, total nitrogen, water-soluble nitrogen, amino nitrogen, and ammonia nitrogen, and, in some cases, sugars and individual silage acids. Dry matter in the silage has been run both by oven-drying and by distillation with toluene. Some of the more notable findings are as follows:

1. The total nitrogen content of the silage is not different from that in the crop unless there is a loss of juice or other disturbing factor.

2. The water-soluble nitrogen of the silage is usually two or three times that of the crop.

3. The amino and ammonia nitrogen are each from five to ten times as plentiful in the silage as in the crop. Excessive amounts of either are indicative of poor quality.

4. The acidity changes from about pH 5.5 to 6.0 in the crop to the rather wide range of pH 3.25 to 5.25 in the silage. The average acidity of 44 hay-crop silages prepared by different treatments was pH 4.40, while the average for 26 samples of corn silage was pH 3.68.

5. Titratable acidity is greatly increased in silage making from about 0.5 to 0.6 per cent in the crop to 1.18 to 3.76 per cent in the silage. The meadow-crop silages averaged 2.5 per cent and the corn silage 3.08 per cent.

6. Sugars which are present to considerable extent in most green crops occur only in very small amounts in silage. They seem to be converted to acids and other organic products which are largely volatile when silage is heated.

7. Silage dry matter as determined by oven-drying will often be from 1.5 to 3.0 percentage units too low, due to the loss of heat-volatile dry materials driven away with the water.

8. Carotene preservation has been rather variable, but it showed a pronounced tendency to be higher in wet and often poor-flavored silages and lower in the silages which are satisfactory from the standpoint of taste and odor.

A. E. Perkins, J. W. Hibbs, and Louise Skinner

EFFECT OF HOLDING TEMPERATURE ON SILAGE CHARACTER

Heavy-walled cylindrical jars were filled with fresh-cut alfalfa having approximately 30 per cent dry matter. The alfalfa was chopped to three different degrees of fineness, approximately 1½-, ½-, and ⅛-inch lengths. Five hundred grams of material were packed in each jar; the jar was then covered with a layer of pliofilm or cellophane. A set of jars, one each of coarse, medium, and fine-cut material, was incubated at approximately constant temperature for a 5-week period. One such set of jars was held at each of four different temperatures. Very little loss of weight occurred in any of the silages.

The silages were judged as to odor, taste, and appearance. Limited chemical analyses were also made. Some differences were noted between the silages of different fineness, but the major differences in the silage character resulted from temperature variation. The silages held at the lowest temperatures, 40° F. or below, changed little in appearance, were bland in taste, and were inclined to develop moldiness; whereas, those at the highest temperatures, near 105° F., acquired an odor and color like that of tobacco-brown hay, were highly acid to the taste, and had very little top spoilage. Strangely, the best carotene preservation occurred in the latter group. Results on the finest-cut material from one typical series are shown below:

Temperature	Appearance	Acidity		Amino nitrogen	Carotene, dry basis
		pH	By titration % acid		
°F.				Pct.	P.P.M.
40	Green	5.70	1.18	.112	60
60	Brown-green	4.42	2.78	.118	20
75	Green-brown	4.42	2.80	.210	29
105	Dark brown	4.15	3.55	.319	77

A. E. Perkins, W. A. Junnila, and C. F. Rogers

Microbiological Studies

THE EFFECT OF THE BACTERIOSTATIC ACTION OF WEAK ACIDS ON SILAGE FERMENTATION

Small quantities of some organic acids (0.05 to 0.1 per cent) applied to plant materials inhibit growths of mold and some bacteria. To test the effect of lactic and acetic acids on later development of lactic-acid bacteria in silage, 10 grams of a 5 or 10 per cent solution of lactic and acetic acids were sprayed on each kilogram of chopped alfalfa before it was ensiled at room temperature in batches of 4 to 10 kg., under constant load.

After 4 to 5 weeks the resulting silages were satisfactory as to pH, total acidity, and other qualities. The effect of the acids was greater and more consistent in the low dry-matter silages than in those of high dry-matter.

The number of species of bacteria in the acid-treated silages was smaller than in control silages.

R. C. Thomas and A. E. Perkins

EFFECT OF ALFALFA AND GRASS EXTRACT ON GROWTH OF SILAGE LACTOBACILLI

Lactobacilli, particularly *Lact. acidophylus* and *Lact. plantarum*, are the predominating microorganisms isolated from a variety of silages. These two species are fastidious in their growth requirements.

A water extract of whole grain seems to satisfy the food requirements of these two Lactobacilli very well; an extract of wheat is less satisfactory, and an extract of alfalfa meal least so. Yet, when an alfalfa extract is added to a medium composed of nutrient broth and dextrose, an excellent growth occurs; whereas, only limited growth takes place if the alfalfa extract is omitted. It is indicated that the alfalfa extract alone is deficient in food material, and yet the presence of vitamins in the extract renders it a valuable amendment to a medium deficient in the vitamins required by the Lactobacilli for their growth processes. This suggests why it may be desirable to add corn meal or some other amendment to alfalfa for silage.

R. C. Thomas

Scoring of the Silages

A score card was devised for the purpose of obtaining a human estimate of the quality of the silages as they were removed from the silos. For a perfect score this card alloted 20 points to the physical condition of the silage, 5 points to color, 45 points to odor, and 30 points to taste.

In 1943, 27 silos were filled with untreated meadow crops or with crops treated in various ways as they were ensiled. Each treatment was duplicated in a 25-ton (or larger) silo and in the Pilot Silos. When the silages were removed from the silos, they were scored by two to six persons and their scores were averaged.

The degree to which these scores agreed with results obtained in palatability trials with various species of farm animals is shown in table 9.

C. C. Hayden, C. F. Monroe, A. E. Perkins, C. E. Knoop, C. F. Rogers, and D. S Bell

Palatability Studies

Four different classes of livestock were used to determine animal preferences for the grass silage produced by the four different treatments. Included in the classes of livestock were ewes, dairy heifers and cows, and beef cows, represented by seven to fifteen head in each group. Three different kinds of silages were

placed in racks which were divided into three compartments. Freedom of animal choice was attained by having an excess of rack-capacity and by offering sufficient amounts of each silage so that the animals could satisfy their appetites from the silage of their preference.

The silages were made from first-cutting alfalfa-timothy-clover mixtures that were harvested from a standing position with a forage-crop harvester. The material was high in moisture, averaging, when ensiled, from 78 to 81 per cent. Four *standard silos* of 18- to 50-ton capacity were filled with the following additions per ton of material: A, 150 pounds of ground ear corn; B, 100 pounds of dry beet pulp; C, 20 pounds of refined cane sugar; and D, no treatment.

Twenty-three Pilot Silos, holding 1,500 pounds of material in addition to 500 pounds of capping, were filled at approximately the same time and with the same material as was put into the standard silos. Two Pilot Silos were intended to be duplicates of each one of the standard silos; one received a slightly modified treatment, and three Pilot Silos were given the other three treatments indicated above.

The results of the palatability trials are summarized in table 9, together with the human ratings.

TABLE 9.—Average daily consumption per head of the different classes of livestock for the four kinds of grass silage, together with the average human score of the silages fed free-choice

Silage treatment	Ewes Lb.	Dairy heifers Lb.	Dairy cows Lb.	Beef cows Lb.	Total Lb.	Human score Average Pct.
From standard silos						
Ground ear corn	3.1	11.1	11.4*	10.4	36.0	87
Beet pulp	1.6	8.5	17.1	8.7	35.9	86
Sugar	2.4	9.1	10.9	6.9	29.3	84
No treatment	0.4	2.8	5.9	6.2	15.3	67
From Pilot Silos (offered along with above)						
Ground ear corn	2.0	5.6	11.1	5.6	24.3	86
Beet pulp	0.7	3.6	4.3	4.2	12.8	83
Sugar	1.8	8.3	7.6	2.5	20.2	81
No treatment	0.2	0.3	0.0	2.8	3.3	57

*Cows cleaned up all that was offered. Consumption probably would have been greater if more silage had been offered.

The combined preference of the animals, based on the silage from the "*Standard*" silos, would rate the silages in the following order: ground ear corn, beet pulp, sugar, and no treatment.

The silage from the standard silos was preferred, without exception, to that from the Pilot Silos. The preference was greatest for the beet pulp-treated and the no-treatment silages.

The tastes of the various classes of livestock were, in general, about the same, with some slight group trends. Thus, the sheep and dairy heifers seemed to prefer the sugar-treated to the beet pulp-treated material; whereas the dairy and beef cows preferred the beet pulp-treated to the sugar-treated silages.

In general, the human score, which represents the average scores of five to six judges, conforms to the preference expressed by the animals. The differences expressed by the animals are more pronounced than those by the human judges. Part of this may be explained by the fact that the scoring was limited to a range of 50 to 100 for edible silages.

C. F. Monroe, C. F. Rogers, W. A. Junnila, Paul Gerlaugh, and D. S. Bell

SORGO SILAGE

Sorgo silage fed to fattening steers at the MADISON COUNTY EXPERIMENT FARM has been inferior to corn silage, not only in daily gains but also in beef produced per acre. Steers have done well on it for 2 or 3 months but after that they fail to put on the pounds or develop the finish that they do on corn silage. Since more care is required in growing sorgo and the resulting crop carries more water which must be handled at silo filling time, it would seem as though corn still will remain the preferred silage crop in Ohio.

Paul Gerlaugh and C. F. Rogers

TRENCH SILO SURVEY

The trench silo survey conducted in Ohio from February to April, 1944, indicated that the successes and failures are about in proportion to how well the principles of proper construction and use of trench silos, as given in mimeographed publications[2] that have been sent to farmers, were used. This is especially true as to packing and covering the silage at the time of filling. The silage should be removed in narrow slices across the end to keep fresh surfaces exposed. Where permanent walls of concrete, brick, or masonry are used the trench silos were in almost continuous and satisfactory use every year. Such silos not only prevent the "mud-hole" situations but may also at times provide storage for other crops, such as fruits and vegetables or even temporary housing for livestock.

[2] "Trench Silos" and "Trench Silos for Emergency" by R. C. Miller.

A new material for covering that proved very successful was the use of a 3- to 4-inch covering of sawdust over tar paper. The sawdust is particularly good for retaining moisture, an important factor in the prevention of spoilage at the top.

A roof on permanent-walled silos that is removable in sections for convenience at filling time furnishes comfort during feeding by keeping out snow and rain. The roof may also be used on earth-walled silos.

The more important features which should be carefully observed in trench silos are listed as follows:

1. The walls should slope outward toward the top. This helps to prevent spoilage against the walls by permitting packing close to the edge of the silage and the silage settles tightly against the wall. The sloping wall also helps to keep the wall in position.

2. The silage should be well-packed at all times while filling. Horses, tractors, or automobiles driven over the silage are the most common methods of packing.

3. A covering of wet straw to a depth of 6 inches is usually satisfactory. A covering of about 4 inches of wet sawdust as used by one farmer was very successful. An earth covering was not found more effective than a thick straw covering, except possibly where the silage is held over for a second year. In one case, a concrete-walled silo held enough for 2 years' feeding. The silage to be kept for the second year was covered with more than a foot of soil. There was less than an inch of spoilage at the top.

Some of the features that particularly appealed to the users of the trench silo were: (1) the silo can be adapted to small herds by filling to a shallower depth; (2) there is no freezing of silage; (3) there is no climbing because the silo is horizontal; (4) the silo can be built for permanence with local labor and materials; (5) an earth-wall trench can be excavated in a few days time for emergency use. Permanent walls and roof can be added later.

R. C. Miller

Grain

CORN

Rate of Planting Corn Hybrids[3]

Studies on the rate of planting corn have shown that the optimum rate for adapted hybrids is heavier than for open-pollinated corn by about 2000 plants per acre. A planting rate of three viable seeds per hill, with the hills spaced 42 inches each way, was best for hybrids when the combination of soil and season was capable of producing 60 bushels per acre or less of shelled grain. As growing conditions were more favorable, the optimum planting rate was one viable seed per hill for each 20 bushels per acre in capacity of the soil and its moisture to produce. With large late hybrids this should be modified to one seed per hill for each 25 bushels in anticipated production capacity of the soil and season.

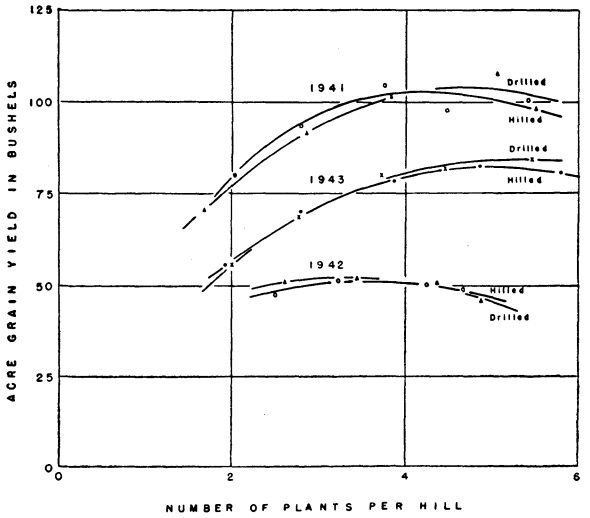


Fig. 15.—A graphic summarization of acre grain yields arranged to compare hilled with drilled corn at varying rates of stand. Wooster, 1941 to 1943.

[3]In cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture.

These recommended rates will give a few bushels per acre less than maximum yields; however, if the stand is adjusted to the point that will give the abosulute maximum yield, there is danger of considerable loss from stalk breakage.

As stands were increased from thin to optimum, there was more stalk breakage, no change in root lodging, markedly less weed growth, fewer tillers, a slight delay in maturity, no change in the bushel-weight of grain, and the ears were reduced in size to an average of about half a pound each when dry enough for cribbing. Large pound-size ears are an indication of inefficient use of favorable growing conditions.

These experiments were conducted with both hilled and drilled corn and the response to stand was practically alike following both methods of planting. A summary of 3 years' work is presented graphically in figure 15.

A more detailed report of these experiments can be had by writing to the Ohio Experiment Station.

G. H. Stringfield

Seed Corn Storage[4]

The safe storage of hybrid seed corn, foundation stocks, and inbred lines is extremely important to the seed-corn producers. A series of tests was started in 1939 to determine the length of life of seed corn under different storage conditions. The results of these tests are shown in table 10, and some conclusions are available from the tests to date. Moisture content of the seeds most critically affects their viability; the storage temperature is next in importance. All seeds containing 18 per cent moisture now are dead. All seeds containing 15 per cent moisture stored at room temperature also are dead, but some stored at low temperature still remain alive. Some slight benefits from storage in carbon dioxide seem to be evident. Ohio W17, a double-cross hybrid, is keeping better than Clarage, an open-pollinated strain. After 5 years, the seeds with low moisture content which were stored airtight at low temperature are germinating satisfactorily. These tests indicate that the useful life of seed corn, at least for breeding purposes, can be extended many years by proper drying and by storing at low temperatures.

[4]In cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture.

TABLE 10.—Viability of two kinds of seed corn following storage in sealed quart tin cans in air and in carbon dioxide.

Seed of the 1938 crop, sealed July 1939

Kind	W17		Clarage		W17		Clarage	
Sealed in	Air	CO_2	Air	CO_2	Air	CO_2	Air	CO_2
Per cent moisture	Room temperature				Low temperature			
	Germination percentages in 1942							
5	78	97	70	98	98	100	100	99
10	10	55	1	17	57	77	86	75
15	0	0	0	0	45	85	32	86
18	0	0	0	0	0	0	6	0
	Germination percentages in 1943							
5	70	73	43	56	78	83	63	68
10	0	0	0	0	67	66	65	65
15	0	0	0	0	6	53	0	35
18	0	0	0	0	0	0	0	0
	Germination percentages in 1944							
5	95	91	59	59	95	92	86	81
10	0	4	0	0	91	98	80	85
15	0	0	0	0	19	86	0	44
18	0	0	0	0	0	0	0	0

J. D. Sayre

Breeding and Evaluating Corn Hybrids for Southern Ohio

Long-season corn strains are required for the productive bottom lands of southern Ohio. Beginning with 1934, preliminary performance trials of late white hybrids were initiated at Chillicothe by the Department of Agronomy, in cooperation with the U. S. Bureau of Plant Industry and the Extension Service of The Ohio State University. Except for 1935 and 1936, trials have been continued. In 1937 they were enlarged to include late yellow hybrids. Performance trials of single crosses were started in 1937 and systematic interstate tests of topcrosses and singles in 1940.

At Chillicothe, during this period over 600 different single crosses, topcrosses, and double crosses have been tested.

The rather general belief among farmers of the river bottom lands that white corns there outyielded yellow corns has been disproved, for certain late yellow hybrids are at least equal in performance to the best of the white hybrids yet tested.

From among the hybrids recurring an adequate number of times in these tests, three have been selected for seed production and general use on the productive bottoms: Indiana 750 and Kentucky 203, both white, and U. S. 379 yellow. These have yield

records averaging 12 to 16 bushels per acre above the best open-pollinated white strains used in southern Ohio, and 7 to 12 bushels above U. S. 13.

As a result of the systematic evaluation of single crosses during the 1940-44 period, there has been, or is shortly to be, put together, in the hand-crossing plots at Columbus and Hillsboro, late yellow and white hybrids potentially more satisfactory in leaf-blight resistance, stalk strength, and yield and quality of grain.

R. D. Lewis and G. H. Stringfield

(See *also* Soil Management)

OATS

Vicland Oats Good in Ohio

Vicland, developed in Wisconsin, has been the best of the new oats varieties for Ohio. Selected from the cross Victoria × Richland, this yellow-kerneled variety is resistant to smuts and rusts. In seasons when diseases are bad, Vicland has considerable advantage over the old, recommended varieties; in seasons when diseases are not a serious factor, it does not yield quite as well. On the average, however, it is superior to Wayne or Gopher in northern Ohio, equal to Columbia in central Ohio, but does not do as well as Columbia in the southern part of the State.

Over a 5-year period, Vicland averaged 4½ bushels per acre more than Wayne at the Experiment Station at Wooster, in spite of the fact that in 1942 it yielded 14 bushels less. The lowest Vicland yield was 65 bushels; while Wayne dropped to 48 bushels in 1940. Vicland will probably give more uniform yields by not going so low in poor years, nor so high in good years as the older varieties.

Weight per bushel of Vicland is good, the variety stands well, and it has no serious weaknesses. It represents a real step forward in the search for better oats for Ohio.

C. A. Lamb

SOYBEANS

Competition Between Single-row Plots in Testing Soybean Varieties

The strength of competition between two varieties of soybeans, Richland (early) and Scioto (medium late), growing in adjacent single rows 2 feet apart was studied at Wooster in 1943 in connection with methods of improving the plot technique in testing soybean varieties and strains.

A four-by-four Latin square design was used, each block consisting of 10 rows with a guard row on each side. The plantings in the blocks were of three kinds, Richland alone, Scioto alone, and alternate rows of Richland and Scioto.

A statistical analysis of the yield data showed that the yield of Richland was depressed when competing with Scioto and that the yield of Scioto was increased when competing with Richland. The yields of Richland and Scioto were significantly different when grown in blocks without competition, but with competition the difference was not significant.

The most significant effect brought out by this analysis is what might be called the difference in competing ability of Scioto (S) and Richland (R).

S (comp.) — S (no comp.) — R (comp.) + R (no comp.) = 6.09 bu. ± 1.53 bu.

L. E. Thatcher

Lincoln—A Truly Great Soybean Variety

Certainly among the outstanding developments during the war period has been the location and increase of Lincoln soybeans. It is an outturn of the cooperative soybean breeding projects of the U. S. Regional Soybean Laboratory and the experiment stations of Ohio, Indiana, Illinois, and Iowa.

This new variety has a phenomenal performance record. In tests in Ohio for 1939-1944, it has averaged 3 bushels more than Mingo, 4 over Scioto, 5 over Dunfield and Illini, and nearly 6 over Richland. Lincoln is less subject to lodging than these varieties, except Richland. Its content of oil is greater than any of the varieties now in use and the quality of the oil is very high. It requires the same length of growing season as Illini and Dunfield, but is about 5 days earlier than Scioto.

Lincoln is a selection made in 1936 from a natural cross of 1934 between a white-flowered strain of Mandarin and Manchu at the Illinois Agricultural Experiment Station. It, and a sister selection, performed so outstandingly in the Ohio tests of 1939 and 1940 that a tentative increase of seed was started in 1941.

The course of the increase of seed of this variety in Ohio by and under the supervision of the Department of Agronomy is a significant wartime accomplishment.

In 1941—1 pound of seed planted on 1/50-acre plot—23 pounds of seed harvested at Columbus.

In 1942—14 pounds of seed planted on 3½ acres—2747 pounds of clean seed harvested at Columbus.

In 1943—2747 pounds of seed planted on 113 acres at 10 locations in Ohio—2803 bushels of cleaned, foundation seed harvested.

In 1944—2803 bushels of foundation seed planted by 160 growers of certified seed in 52 counties of Ohio. Approximately 70,000 bushels of certified seed harvested.

This outstanding yielding ability and oil content, reinforced by the multiplication of the seed under certification, could easily result in 500,000 acres being planted to Lincoln in Ohio alone in 1946. From that acreage would come at least 1,500,000 more bushels than from the varieties previously used. To the processor would accrue 35,000 additional tons of meal and 7,000,000 more pounds of oil. These gains at present prices add up to more than $5,000,000.

R. D. Lewis, L. C. Saboe, and L. E. Thatcher

Defoliating Soybeans to Facilitate Harvesting

Where soybeans are raised for seed, the combine has proved the most popular means of harvesting them. However, if this implement is used, it is necessary in most cases to wait until there is a killing frost before the crop can be harvested in order that the leaves will have dried up or fallen from the soybean plots and that any weeds present will have dried up. This is necessary so as not to interfere with the operation of the combine or with the soybean grain keeping in storage.

This delay in harvesting has two undesirable aspects: First, it usually delays harvest until it is impossible to seed a fall-sown cereal on time, or perhaps makes such seeding impractical; second, harvesting may be delayed until bad weather sets in, and, as occurred in many places in the fall of 1942, it may be impossible to harvest the crop at all.

Trials were conducted in 1943, and again in 1944, using a finely powdered form of Cyanamid, known commercially as Aero Defoliant, to defoliate the plants. Experience has shown that 75 to 100 pounds per acre will completely defoliate soybeans in a week. Applications as heavy as 250 pounds per acre kills the leaves but they cling to the plant afterwards.

If dusting is done before the beans have matured to the point where at least half of them have lost their green color, the yield suffers because of reduced size of individual beans.

In 1944, dusting was done on two dates 11 days apart. Within 24 hours after the last date of dusting the plants froze, killing all the leaves. Nevertheless, those that had been dusted lost moisture

more rapidly than those not dusted. The following tabulation illustrates this, as well as the lowering of the yield when the plants are dusted when too immature.

	Moisture content of beans			Yield per acre
	Sept. 29	Oct. 6	Oct. 13	
	Per cent	*Per cent*	*Per cent*	*Bu.*
Not dusted	46.9	31.2	20.6	16.8
Dusted September 11 (100 lb. per acre)	23.2	17.9	14.3	13.9
Dusted September 22 (100 lb. per acre)	30.1	19.0	15.0	15.8

Defoliation of soybeans before combining is still in the experimental stage, but the following facts seem to be established: (1) Soybeans can be completely defoliated in a week's time by dusting with 75 to 100 pounds of Cyanamid dust, known commercially as "Aero Defoliant"; (2) When double this quantity is used the leaves are killed, but they continue to cling to the plants; (3) The germination of beans harvested from defoliated plants is not injured; (4) Dusting at immature stages lowers the oil content slightly; (5) Defoliation tends to reduce the ash content of the beans; (6) Aero Defoliant is effective in killing most weeds which are common in soybean fields. Smart weed was the least affected of any of the weeds noted.

E. E. Barnes

WHEAT

New Thorne Wheat Widely Grown

Thorne wheat has spread very rapidly in Ohio and has moved on to the states south and east. Starting from approximately 60 bushels distributed in 1937, Thorne was estimated to occupy roughly two-thirds of the whole Ohio wheat acreage in 1943, or something more than 1,000,000 acres. This is the greatest acreage ever grown in one variety in Ohio. Thorne has also done well in tests in Kentucky, Tennessee, Pennsylvania, and North Carolina, and it it recommended for certain areas in all these states.

In Ohio, Thorne has outyielded older varieties by approximately 3 bushels in 10 to 15 years of testing. It has a very stiff straw and is excellent for combine harvesting. The flour is high quality for soft-wheat products, such as cakes, crackers, cookies, etc. The most serious weaknesses of Thorne are slightly lower weight per bushel and more severe damage from scab than other recommended

varieties. Scab injury has been severe some years in southwestern Ohio. New lines, superior to Thorne in these respects, are at present on test, and it is hoped may soon be released to the farmer.

C. A. Lamb

New Wheat Quality Test is Promising

The market price of wheat depends in no small measure on the characteristics of the flour made from it. Ohio wheat classes as Soft Red Winter, and the flour is used for crackers, biscuits, cookies, cakes, etc. The baker of these products must have a flour that meets exacting standards in order to have cookies, for example, uniform in size for packaging and high in quality for eating. Quality is one of the most important characteristics to be evaluated in new strains developed in the wheat improvement program.

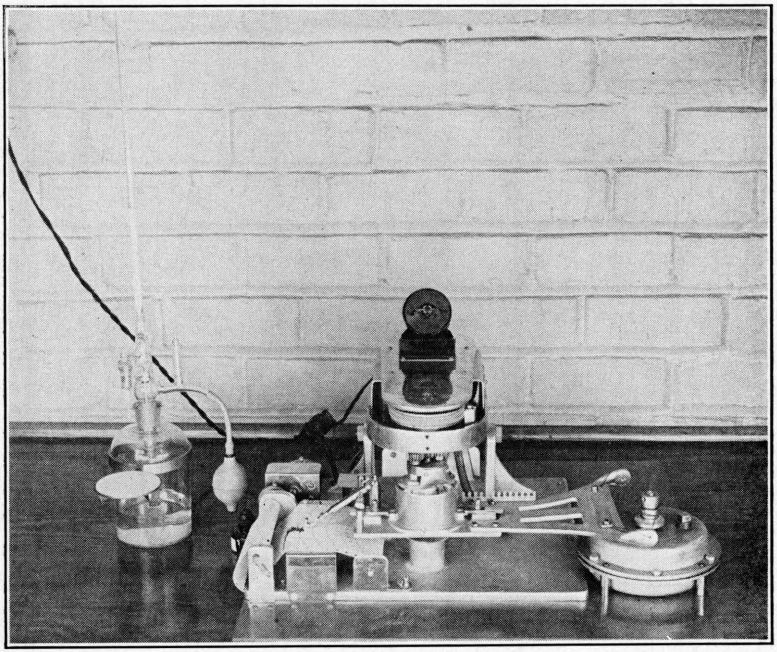


Fig. 16.—The recording micro-mixer provides a new quality test of value in the wheat improvement program.

Tests for soft wheat quality have not been entirely satisfactory; they have been largely flour tests. In a wheat improvement program, many lines are grown and there is not sufficient grain for

milling. As a result, it has been necessary to carry new strains far along in the program before quality could be more than roughly estimated.

A sifted wheat meal from only 125 grams of wheat will provide sufficient material for making duplicate mixograms on a recording micro-mixer. This machine uses a water-meal mixture and makes a continuous record of the tension required to work the dough mass. The characteristics of this graph-record can be interpreted in terms of quality. The test does not permit positive classification, but it is a definite step in that direction. Many of the characteristics of the graph record cannot yet be explained, but further work should make the test even more valuable. As developed to date, the mixogram is a great help in eliminating strains with undesirable quality from the wheat-breeding program at an earlier stage than was previously possible.

C. A. Lamb

INSECT CONTROL

The European Corn Borer

In 1943 the most severe corn-borer infestation in dent corn occurred in the area centered around Madison, Clark, Miami, and Champaign Counties. Sweet corn was damaged severely in the market-garden areas near Dayton and Cincinnati. In previous years serious corn-borer injury had been confined largely to northwestern Ohio.

The marked increase in borer infestation in southern Ohio is attributed, at least in part, to a strong development of a second generation in that area. Although some second-generation infestation has occurred in recent years in all sections of the State, its importance was accentuated in southwestern Ohio. The infestation of borers in the earliest corn that developed a second generation varied from about 25 per cent at Elyria in northern Ohio to 75 per cent at Cincinnati. The moths of the second generation were in flight from late July through mid-August.

The percentage of borers of the first generation that develop a second generation varies with the strain of corn. Just as a higher borer survival occurs in the earliest maturing corn strains, likewise a higher percentage of moth emergence for a second generation occurs in those strains. For this reason, it is likely that the concentration of early sweet corns in market-garden areas has been responsible, in part, for the general increase in second-generation borers.

The appearance of a second generation of corn borers has complicated the time-of-planting recommendation for corn-borer control. When there was only a single generation of borers per year, one of the control measures was late planting because the moths preferred to deposit eggs on the tallest corn. Also, the borer survival was low if the corn was small at the time eggs were deposited. Now that two generations occur annually, the first generation behaves like the single generation did formerly and attacks the earliest corn. The second generation, on the other hand, avoids the earliest plantings and attacks relatively late-planted corn, although not necessarily the latest. Consequently, the optimum planting date under two-generation conditions would be one that is late enough to escape maximum egg deposition from first-generation moths but also early enough to escape maximum egg deposition from second-generation moths. Inasmuch as the moths emerge from 10 to 15 days earlier in southern than in northern Ohio, no specific planting date can be designated for the State as a whole.

Also, the appearance of large numbers of second-generation borers has complicated the investigation of corn-borer resistance or susceptibility in that many strains that have shown resistance to the first generation do not exhibit the same resistance to the second generation. It appears now that corn-borer resistance or susceptibility in corn strains is not a specific character that is peculiar to certain strains at all stages of growth, but rather it is a relationship between the corn plant and the insect that varies with certain physiologic changes in the plant as it progresses towards maturity.

C. R. Neiswander

Livestock and Poultry

BEEF CATTLE

The Feeding Value of Corn Cobs in Steer Fattening Rations

Several experiment stations have compared shelled corn, ground shelled corn, and corn-and-cob meal for fattening steers. The results have not always been in agreement.

The Ohio Experiment Station conducted three tests with steer calves and two tests with yearling steers comparing shelled corn and corn-and-cob meal. The results of these tests were favorable to corn-and-cob meal. If corn-and-cob meal is preferable to shelled or ground shelled corn, then is the generally accepted ratio of 14 pounds of cobs to 56 pounds of shelled corn the best ratio for use in a steer fattening ration?

In order to obtain information on this point, three lots of 20 steer calves each were group fed, and three lots of 12 head each were individually fed for a period of 252 days. Two pounds of mineralized soybean oil meal were fed daily per calf; mixed hay was fed to all lots. To one lot of group-fed steers and to one lot of individually-fed steers, ground shelled corn was fed. The shelling percentage was obtained when the corn was shelled. To another lot of each, regular corn-and-cob meal was fed. To the third lot of each, a corn-and-cob meal containing added cobs was fed. This corn-and-cob meal was prepared by adding as many pounds of cobs to a ton of ear corn as were obtained from shelling a ton of ear corn for use in the ground shelled corn-fed lots.

In the group-fed lots, the ground shelled corn-fed steers gained 1.97 pounds daily, the regular corn-and-cob meal-fed lot gained 1.99 pounds daily, and the corn-and-cob meal with added cobs lot gained 1.93 pounds daily. The individually-fed lots gained 1.72, 1.76, and 1.62 pounds, respectively. When the group-fed cattle were slaughtered, the ground shelled corn cattle dressed 61 per cent; the corn-and-cob meal lot, 60.2; and the added cob lot, 59.6 per cent.

The individually-fed lots dressed 59 per cent, 57.3 per cent, and 55.7 per cent, respectively. The carcasses of all the group-fed cattle were in the choice grade. The carcasses of the individually-fed cattle were not graded.

A second test was conducted in which yearling steers were used. The lots of 12 head were fed as three groups of four steers each instead of being individually fed. These cattle were fed 196 days. The ground shelled corn cattle gained 1.94 pounds daily in the 20-head lot, and 2.01 pounds daily in the lots of 12 head. These lots dressed 62.3 per cent and 62.7 per cent, respectively. The regular corn-and-cob meal lots gained 1.91 pounds daily in the 20-head lot, and 1.98 pounds in the 12-head lot—showing dressing percentages of 62 per cent and 62.3 per cent, respectively. The lot of 20 head fed the corn-and-cob meal with the added cobs gained 1.87 pounds daily and dressed 61.2 per cent, while the 12-head lot gained 1.98 pounds daily and dressed 62.3 per cent. There were four carcasses grading good in each of the groups of 20, with the remaining carcasses in the choice grades. The groups of 12 graded somewhat higher than the lots of twenty.

The replacement value of the cobs in terms of shelled corn was from 50 to 60 per cent at the close of each year's tests. The replacement value of the cobs diminished as the test progressed from a level of about 75 per cent at the end of 5 or 6 months feeding.

Several digestion trials were conducted during this same period, approaching this problem from several different angles. Four steers were used in each trial.

Steer calves were fed ground shelled corn and corn-and-cob meal containing 20 per cent of cobs along with alfalfa hay and protein concentrate in amounts similar to levels fed at the start of a fattening period, midway through a feeding period, and during the latter part of a feeding period. In these trials 53 per cent of the nutrients in the corn cobs was digestible.

A second digestion trial compared rations of ground shelled corn with rations of ground shelled corn to which was added 10 per cent of ground cobs in one case, 20 per cent of cobs added for another case, and 30 per cent of cobs added for a fourth ration. The results of this trial showed the nutrients in the cobs to be 53 per cent digestible, although the ration containing the 30 per cent of cobs was noticeably lower than the other levels.

When ground cobs were substituted for 10, 20, and 30 per cent of the alfalfa hay in an all-hay basal ration, it was found that 58 per cent of the nutrients in the cobs were digestible. The higher digestibility of this test may in part be due to the fact that the ration would be considered a maintenance ration rather than a fattening ration.

In another digestion trial ground corn cobs, with 10 per cent of dried buttermilk added, were fed at the rate of 5.5 pounds daily to each of four steers. Assuming that the dried buttermilk was 100 per cent digestible, the ground cobs showed 50 per cent of their nutritive content to be digestible.

The experimental lots and the digestion stalls indicated that corn cobs have a distinct feeding value in the ration of fattening cattle. This value has decreased as the feeding period advanced. In the production of cattle of choice grade this value has been over 50 per cent, while a higher value, 75 per cent, has been obtained when the cattle were in a condition to grade high-medium or possibly low-good.

Paul Gerlaugh, E. W. Burroughs, and L. E. Kunkle

Crossbreeding Beef Cattle

In 1939 the Ohio Experiment Station purchased a herd of 28 purebred, open, Aberdeen Angus heifers of breeding age and a similar number of purebred Hereford heifers. One-half of the Angus heifers was bred to an Angus bull, and the other half was bred to a Hereford bull. The same plan was followed with the Hereford heifers, using the same bulls. The second year, the cows of both breeds that had given birth to a purebred calf the first year were bred to give birth to a crossbred calf. The third year, new bulls of both breeds were purchased and the cows allotted the same as for the first calf crop. For the fourth calf crop, the cows were allotted as for the second calf crop and the same bulls used as sired the third crop. For the most part, each cow of both breeds has raised two purebred and two crossbred calves during the 4-year period.

This report covers the results of raising, fattening, and marketing, as baby beeves, the four crops of calves. The calves have been born during late summer and fall, usually on bluegrass pasture. All cows and their calves have been wintered in the same barn. The cows have received, on the average, 35 to 40 pounds of corn silage and 1.5 pounds of mineralized protein concentrate daily. Shredded corn stover and straw have been used as both feed and bedding.

Hay silage or corn silage has usually been fed during the late summer, when the cows were needing some feed in addition to the pasture available.

TABLE 11.—Summary of first four calf crops

Purebreds versus crossbreds

	Number of calves	Gestation period, Days	Birth weight of calves, Lb.	Average age at weaning, Days	Average daily gain, birth to weaning, Lb.	Average daily gain in feed lot, Lb.	Corn-and-cob meal per cwt. of gain, Lb.	Dressing percentage	Carcass grade	
									Choice	Good
Purebred Angus steer calves	32	277	60	232	1.89	1.58	603	60.52	24	7
Crossbred steer calves from Angus cows	28	282	61	221	1.87	1.70	535	60.55	22	5
Purebred Angus heifer calves	23	274	52	232	1.70	1.51	580	61.33	16	5
Crossbred heifer calves from Angus cows	19	281	57	212	1.71	1.54	495	60.60	15	4
Purebred Hereford steer calves	21	290	65	213	1.60	1.68	466	59.52	17	5
Crossbred steer calves from Hereford cows	25	282	64	216	1.64	1.69	531	60.13	17	7
Purebred Hereford heifer calves	26	287	67	210	1.52	1.54	481	59.53	18	7
Crossbred heifer calves from Hereford cows	25	285	62	210	1.60	1.61	538	60.69	17	7

The Hereford cows averaged 1180 pounds and the Angus cows, 1140 pounds, on October 26, 1944, when the majority of the cows were nursing calves.

Creeps have been available for the calves in the barn. Here corn silage, hay, corn-and-cob meal, and protein concentrate have been available to the calves.

The bull calves have been castrated when about 2 months old and the Hereford calves have been dehorned several weeks prior to weaning. The calves have been weaned during the latter part of April and taken to another barn for the feed-lot test. Usually 2 weeks have elapsed between weaning and starting on the feeding test.

Individual feeding has been practiced in the feed lot. Five pounds of corn silage, 1.5 pounds of protein concentrate, and 1.5 pounds of mixed hay, cut into inch lengths, have been fed daily in addition to a full feed of corn-and-cob meal. It has been our experience that individually-fed calves do not eat as much nor gain as rapidly as group-fed calves.

Table 11 gives information obtained from the various groups over the 4-year period. Reference was made above to the effect that different bulls of each breed were used for the last two crops of calves. Some attention was paid in selecting these bulls to their relativte size. The results obtained by the calves sired by bulls of varying sizes is another chapter which we hope will be available soon.

Paul Gerlaugh, D. C. Rife, and L. E. Kunkle

Poor Hills or Good Beef, Which?

On the SOIL CONSERVATION EXPERIMENT FARM near Zanesville, the trash-mulch system of seeding has been developed as a means of quickly converting poverty grass covered hills to alfalfa-grass meadows. Now, encouraging progress is being made in carrying the project one step farther, whereby these meadows are converted into beef through winter hay and summer pasture. Creditable beef sold off of pasture (which the market takes without hesitation) has been produced by feeding approximately 5 bushels of corn per 2-year-old steer during the last 2 months of pasture.

H. L. Borst, M. A. Bachtell, Paul Gerlaugh, and R. E. Yoder

DAIRY CATTLE

Calcium and Phosphorus Levels Affect Reproduction

Even under favorable conditions losses of calcium and phosphorus from the maternal body frequently occur. It is not clear, however, whether pregnancy or lactation takes precedence in the competition for the maternal stores of calcium and phosphorus. To help answer this question, 48 female rats were divided into three dietary groups of 16 animals each and were fed the following diets: A. The standard stock colony diet; B. A highly purified diet containing 0.018 per cent calcium and 0.245 per cent phosphorus (Ca : P=1 : 13); and C. A highly purified diet containing 0.122 per cent calcium and 0.245 phosphorus (Ca : P=1 : 2). These groups were further subdivided into two groups of eight rats each for each diet. The animals in one group on each dietary regime were mated; the others were maintained on the same diet as controls.

TABLE 12.—The effects of restricted calcium and phosphorus intake upon reproductive performance

Diet group	Females	Reproductive performance				Per cent raised	Maternal femur bone ash
		Litters		Offspring			
		Born	Raised	Born	Raised		
		No.	*No.*				*Pct.*
A —Basal	8	24	16	156	89	57.1	63.01
A	8 (not bred)	.....	.....	.....	.....	.....	65.46
B —Ca 1:P 13	8	22	7	142	36	25.4	57.01
B	8 (not bred)	.....	.....	.....	.....	.....	63.68
C —Ca1:P 2	8	22	12	136	61	44.9	60.44
C	8 (not bred)	.....	.....	.....	.....	.....	64.60

The results, summarized in table 12, show rather conclusively that in the rat reproduction takes precedence over lactation in competition for maternal stores of calcium and phosphorus.

T. S. Sutton

Levels of Carotene and Vitamin A in the Blood Plasma of Dairy Cows

In order to determine the state of vitamin A nutrition in adult cows by means of a blood-vitamin test it is necessary first to determine normal blood values throughout the year under normal conditions of feeding and management. To establish such base values blood samples from six cows of four dairy breeds (Ayrshire, Guernsey, Jersey, and Holstein) were obtained monthly and analyzed for carotene and vitamin A.

Average vitamin A values varied from a high of 23.0 micrograms per 100 cc. of plasma in October to a low of 18.4 micrograms per 100 cc. in March. Breed and individual cow variations were somewhat greater than this but they followed the same general trends. Average carotene values varied from a high of 1542 micrograms per 100 cc. of plasma in May to a low of 387 micrograms in February. Breed and individual variations in blood-plasma carotene were much greater than those for vitamin A.

Changes in blood vitamin A values do not correspond exactly with blood-plasma carotene changes. As fall pastures became short, blood-plasma carotene dropped precipitously; at the same time, vitamin A increased, reaching a peak in October and remaining at a high level through December. With continued low carotene intake, vitamin A then dropped sharply in January and continued downward through March. Increased carotene intake following a period of low carotene intake resulted in a rapid rise in vitamin A, followed by a sharp fall.

To study blood changes that occur at parturition, samples were drawn at weekly intervals for 3 weeks preceding parturition, immediately following parturition, and at 3, 7, and 14 days following parturition; these samples were analyzed for carotene and vitamin A. The results are shown in figure 17.

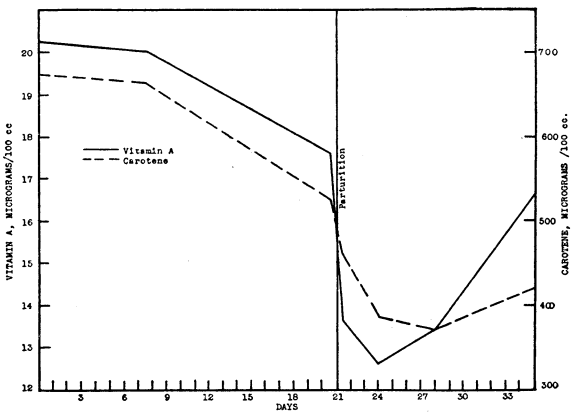


Fig. 17.—Blood plasma vitamin A and carotene changes at parturition (averages of 20 cows)

The sharp drop in blood-plasma carotene and vitamin A that occurs immediately prior to parturition and continues for several days post partum cannot be accounted for on the basis of dietary changes. This probably is a reflection of the severe drain on body

reserves. This contention is substantiated by the fact that vitamin A and carotene are much more highly concentrated in colostrum than in normal milk and that the first precipitous drop occurs at about the time the udder becomes distended with secretion.

T. S. Sutton

Vitamin D May be an Aid in Controlling Milk Fever

The daily feeding of 1 million units of vitamin D in the form of irradiated yeast to cows during the last 30 days of the dry period may be helpful in controlling milk fever, especially in cows with previous histories of this difficulty. A comparison of the incidence of milk fever in yeast-fed cows with those fed no yeast is shown in table 13.

TABLE 13.—Effect of feeding irradiated yeast on the incidence of milk fever

	Total	Yeast-fed	Controls
All cows			
Total freshenings	167	78	89
Normal	129	59	70
Milk fever	38	19	19
Incidence, per cent	22.8	23.4	21.3
All Jerseys			
Total freshenings	94	47	47
Normal	63	33	30
Milk fever	31	14	17
Incidence, per cent	33.0	29.8	36.2
Jersey "Addicts"			
Total freshenings	35	20	15
Normal	17	12	5
Milk fever	18	8	10
Incidence, per cent	51.4	40.0	66.7

A detailed study of the blood-serum calcium, phosphorus, and magnesium at parturition revealed a sharp drop in calcium and phosphorus and an increase in magnesium prior to the onset of milk fever. Figure 18 shows the blood changes that occur at parturition.

A similar study of the vitamin D levels in whole blood of yeast-fed and control cows showed that a decline in the vitamin D level of the blood before freshening occurs normally. Irradiated-yeast feeding resulted in an increase in blood vitamin D in both normal

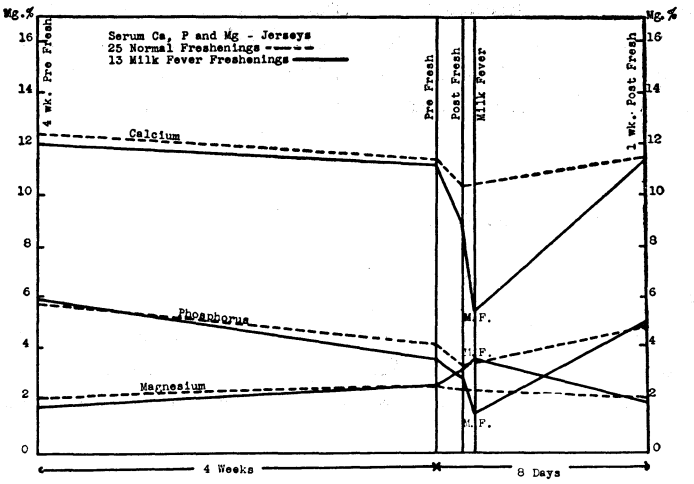


Fig. 18.—Changes in the serum calcium, phosphorus, and magnesium at parturition in normal and milk-fever cows.

and milk-fever cows. This shows that it is possible for some cows to have milk fever even though the blood vitamin D is high (Fig. 19).

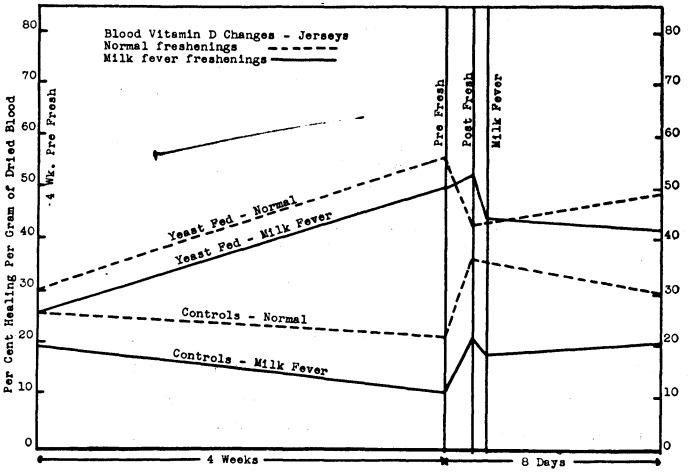


Fig. 19.—Blood-vitamin D changes in normal and milk-fever cows

Further work on this problem is necessary before specific recommendations can be made as it is now apparent that the use of irradiated yeast as described is not an absolute preventive.

J. W. Hibbs, W. E. Krauss, C. F. Monroe, and T. S. Sutton

Amino Acids Improve Storage Qualities of Spermatozoa

A superior diluting medium that would maintain fecundity in spermatozoa for 2 to 3 weeks would result in many advantages that would encourage greater use of artificial insemination.

A study of various procedures has revealed that supplementing a buffered egg-yolk diluent with gelatin doubled the time that living sperm cells remained active in storage.

The addition of alpha or beta alanine, arginine, glycine, or proline to the buffered egg-yolk diluent tripled the period of high rate of cell activity in storage. This indicates that the amino acids used had some supplementary effect on the amino acids naturally present in gelatin.

The addition of amino acids to diluted semen did not interfere with the ability of such semen, after 6 to 10 days in storage, to settle cows.

C. E. Knoop

Feeding of Skimmilk or Potassium Iodide Improves Semen Quality

Preliminary studies with a problem bull revealed that feeding a high-protein mineral feed, iron and copper salts, iodinated casein, or shark liver oil appeared to be of little value in improving spermatogenesis; whereas the daily feeding of potassium iodide (40 milligrams) or dry skimmilk (0.6 pound) increased sperm cell output approximately 30 per cent. Skimmilk feeding also improved motility and viability of the cells in storage.

Some bulls are noted for their ability to produce excellent quality semen throughout most of the year, while other bulls, similarly raised or bred, produce inferior quality semen. When those factors which assist in the production of excellent quality semen are found, many more good bulls will be available for artificial breeding.

C. E. Knoop

SHEEP

Legume-grass Silage for Roughage

During each of four winter feeding periods, tests have been conducted to study the palatability, usability, and extent of use of legume-grass silage as succulent roughage in the winter ration of pregnant and nursing ewes and growing ewe lambs.

For all tests an alfalfa-clover-timothy forage was cut at an early hay-cutting date (about June 10th to 15th) and chopped directly into an upright wood-stave silo. The dry matter content of this forage varied from year to year, but it ranged between 18 to 25 per cent. During 3 years, 50 to 60 pounds of cane molasses were added as carbohydrate material to each ton of chopped green forage to induce the fermentations and changes which result in good silage. During the fourth test—with cane molasses unavailable—150 pounds of ground ear corn were added to each ton of chopped forage put into the silo. Very good to excellent legume-grass silage resulted each year. In instances where high-moisture forage was ensiled there was some leakage. Roughly, all silages, including the corn silage, contained about 28 per cent dry matter when fed.

In all experiments the check-lot ration consisted of mixed grain, legume hay (*ad lib.*), and 3 pounds of corn silage daily per ewe or 1.5 pounds per growing ewe lamb. Thus far, legume-grass silage has been fed:

1. To replace the corn silage, as above.
2. To replace the legume hay, as above.
3. To replace both the legume hay and corn silage, as above (legume-grass silage being used as the sole roughage).

Table 14 gives some pertinent data from the test where legume-grass silage was fed as the sole roughage. It will be noted that the ewes fed the check-lot ration gained somewhat more during the pregnant period and lost less during the nursing period than the ewes fed legume-grass silage. This probably reflects the

TABLE 14.—Average ration and gain or loss in weight—December-April, 1944 (140 days)

	Grain†	Legume hay	Corn silage	Legume silage	Gain in weight of ewes		Gain in weight of lambs
					Pregnant	Nursing	
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Shropshire ewes: Check lot	0.61	1.68	3.00	....	28.4	— 3.7	0.302*
Legume-silage lot....	.61	.....	.....	6.32	23.5	— 5.1	.405*
Merino ewes: Check lot ...	.68	1.72	3.00	.....	28.1	+5.03	.309*
Legume-silage lot.....	.67	.....	.....	7.26	25.8	—0.00	.377*
Shropshire ewe lambs:							
Check lot	.75	.72	1.5	.....	.....	.....	22.57
Legume-silage lot.....	.75	.....	.....	3.46	.....	.....	25.08
Merino ewe lambs:							
Check lot	.75	.81	1.5	.....	.....	.....	27.36
Legume-silage lot.....	.75	.....	.....	3.71	.....	.....	28.00

*Average daily gain of nursing lambs born to ewes in lot fed as indicated.

†Grain for ewes consisted of: equal parts corn and oats, plus 0.15 pound soybean oil meal daily per head. For lambs, it was 6 parts corn, 3 parts oats, 1 part wheat bran, and 1 part soybean oil meal; all parts by weight.

extra corn in the corn silage-fed lots. The nursing lambs from the respective lots reverse the picture, as do also the growing ewe lambs, fed legume-grass silage as the sole roughage.

It may be that the preservation in legume-grass silage of the milk stimulating-growth promoting factors, which are regarded to be present in fresh high-quality, legume-grass forage brought about the results recorded for the lambs. In any event, the 4 years' tests with legume-grass silage show that such silage of good quality is palatable and usable in sheep rations and may even be used to the extent that it is fed as the sole roughage in the winter ration of ewes or growing ewe lambs.

Other experiments in progress during the year include:

(1) Types of sheep for Southeastern Ohio.
(2) Preparation of corn for fattening lambs.
(3) Establishing meadows and pastures for sheep.

In addition, the foundation for a flock of Columbia sheep was secured—the object being to study the adaptability of this breed to Ohio's conditions and the place of the breed in Ohio's sheep industry.

D. S. Bell

SWINE

Source of Protein for Pigs on Pasture

Protein supplements of (1) tankage, (2) soybean oil meal, and (3) soybean oil meal and linseed and cottonseed meal in a 4:1:1 ratio were compared for feeding with corn and minerals to pigs on mixed alfalfa and clover pasture. The corn was ground and the feeds were mixed so that each ration contained approximately 14 per cent of total protein until the pigs averaged 125 pounds in weight, and 12 per cent thereafter. Sufficient minerals to give a total mineral content of 4.3 per cent were fed. Self feeding was practiced.

With minerals in the ration, a plant protein was as effective as an animal protein concentrate and a mixture of plant protein feeds was no more effective than was a single plant protein concentrate. In "free-choice" feeding, mixing the protein concentrate with a small grain, a mill feed, or with other high-protein feeds and adjusting the proportions may be necessary to keep the pigs from taking too little or too much.

W. L. Robison

Amount of Protein for Pigs on Pasture

One group of pigs was given a ration containing an ample amount of protein, or 14 and 12 per cent, respectively, before and after they averaged 125 pounds in weight. A second group was given a reduced allowance. Its ration contained 12 and 10.4 per cent for the two periods, respectively. A third group was given approximately the same total amount of protein concentrate as Lot 2 but was given a full allowance during the first and no protein concentrate during the second period. The feeds were mixed and all of the groups were self-fed. Each had an abundance of good pasture.

The pigs on the low-protein rations ate noticeably larger amounts of pasture but gained more slowly and were fatter and less growthy at 220 pounds, or a given weight, than were those fed more protein. They also took more feed per unit of gain, but, since it cost less a pound, the feed costs per 100 pounds of gain were not greatly different. When the supply of protein was limited, a liberal amount while the pigs were young and no protein concentrate later appeared preferable to a reduced amount for the entire time. The full and the reduced allowances were equivalent to approximately 0.7 and 0.4 pound of 40 per cent supplement, or to 0.27 and 0.15 pound of protein in the supplement, daily a head.

W. L. Robison

Soybean Oil Meal for Pigs in Dry Lot

In dry-lot experiments, pigs fed soybean oil meal with corn, ground alfalfa, and minerals which were given a fifth of a pound of irradiated yeast per ton of feed as a source of vitamin D required 2.4 per cent less feed per unit of gain but gained more slowly than pigs fed tankage and linseed. A higher percentage of those fed soybean oil meal ceased to gain or began losing in weight and were removed from the experimental lots. Many tended to fatten rather than grow and develop normally. Some became wrinkly and rough in the skin. Some became wheezy or developed difficult respiration; this was accentuated with the least amount of exercise. When the ration contained some tankage or animal protein feed the pigs grew and developed normally. Adding various materials other than tankage to the ration was tried.

Ground oats, fed at the same rate as the soybean oil meal, were of some benefit. In one trial, the pigs suffered from an attack of "flu" toward the close of the test. Until then, or to an average

weight of 184 pounds, those without and those with oats gained 0.99 and 1.14 pounds daily a head and required 388 and 371 pounds of feed per 100 pounds of gain, respectively. In another, the pigs without and with oats gained 1.07 and 1.09 pounds daily a head and required 392 and 373 pounds of feed per 100 pounds of gain, respectively.

Linseed and cottonseed meal were tried with soybean oil meal in a 1:1:4 ratio. In the first and in the second trials the pigs receiving them gained 9 and 17 per cent faster, respectively, than those not receiving them. In the first trial, these feeds did not alter the efficiency of the ration. In the second, they reduced the feed required per unit of gain 3 per cent.

Soybean oil, equivalent to that in soybeans, was tried in one experiment. The pigs receiving it gained 6 per cent faster and required 5 per cent less feed per unit of gain than those without it. In experiments with other rations and other fats, increasing the fat content of the ration likewise increased the rate and efficiency of the gains.

Additional ground alfalfa, 15 instead of 5 per cent, until the pigs averaged 125 pounds in weight, was fed in one of the two tests. A commercial sun-cured alfalfa meal, containing 12 per cent of protein and 31 per cent of fiber and showing 9450 units of vitamin A per pound and 14.3 units of riboflavin per gram, was used. This and the other groups received 3 per cent of ground alfalfa after they averaged 125 pounds in weight. The added alfalfa during the growing period had little effect on the rapidity of the gains for the entire time. It raised, rather than lowered, the amount of feed required per unit of gain.

Legume silage was fed in the winter tests. It was placed before the pigs in a trough. The mixture of corn, soybean oil meal, ground alfalfa, and minerals was kept before them in a self-feeder. Under these conditions they ate a negligible amount of silage. Brood sows ate it readily. Presumably legume silage could be used as a corrective if the other feed was restricted. Limiting the other feed, however, would materially reduce the rapidity of the gains.

Dried brewers' yeast was fed at the rate of 1.5 per cent in the first test and 2 per cent in the second. In the first trial to average weights of 184 pounds, the pigs without and with it gained 0.99 and 1.02 pounds daily a head and required 388 and 387 pounds of feed per 100 pounds of gain, respectively. In the second, those without and with it gained 1.07 and 1.16 pounds daily a head and required 392 and 377 pounds of feed per 100 pounds of gain, respectively.

Figured at 10 cents a pound, the dried brewers' yeast increased the cost of the gains 48 cents a 100 pounds in the first and 16 cents a 100 pounds in the second trial.

Growing yeast in the feed produced faster gains and greater gains per unit of feed in both trials. Water was added and yeast was allowed to grow for 24 hours in the wet feed, which was kept at a favorable temperature for the yeast's development. A cake of yeast was used at the start. Thereafter the yeast was propagated by pouring some of the wet mash containing growing yeast from the feed for one day into that for the next. Since only a few renewals of the culture with fresh yeast were required, the cost of the yeast was approximately a cent per pig for the entire time. In the first trial all of the lots were fed twice daily. In the second trial, except for the group given the wet feed containing growing yeast, they were self-fed. Growing yeast in the feed enabled the pigs to be marketed 26 days earlier. It increased the average gains from 1.03 to 1.23 pounds daily a head and lowered the feed required per 100 pounds of gain from 390 to 363 pounds. It lowered the cost of feed per 100 pounds of gain from $8.90 to $8.30.

Tankage, or an animal protein feed, in place of a part of the soybean oil meal, as mentioned, produced normal growth and development. The self-fed pigs without and with it gained 1.07 and 1.29 pounds daily a head and required 392 and 375 pounds of feed per 100 pounds of gain, respectively.

W. L. Robison

Crossbreeding Hogs

Since 1936 a three-breed crossing system has been followed at the MIAMI COUNTY EXPERIMENT FARM. Purebred sires of the Poland China, Hampshire, and Duroc Jersey breeds were used in rotation on successive generations of sows selected from the herd; these, therefore, after the second generation were a mixture of the three breeds. Pigs from these matings were compared with purebred Duroc Jerseys. They were ready for market 8 days earlier, on the average, than were the purebreds, and the average number saved to market was 0.8 more per litter for them than for the purebreds. At 6 months of age the crossbreds averaged 229 pounds heavier per litter than the purebreds. For 10 generations no difficulty was experienced in selecting crossbred gilts that developed into satisfactory brood sows.

It is planned to repeat the comparison and to include a second crossbred group, which will be produced by using inbred rather than outbred purebred sires of the three breeds.

W. L. Robison and P. A. Jones

Crossing Inbred Lines of Swine Within a Breed

Matings of inbred sires (1) to inbred dams of the same line, (2) to inbred dams of other lines, (3) to outbred dams, and (4) to dams produced by crossing two other inbred lines were compared with matings of outbred sires to unrelated outbred dams. The matings were within the Duroc Jersey breed so that all of the resulting pigs were purebreds.

Pigs of the first group, which were themselves inbred, were lacking in vigor and made slow and costly gains. Although an average of 9.8, or 88 per cent, as many live inbreds as outbreds were farrowed per litter, only 3.7, or 44 per cent, as many per litter lived to 180 days of age. A larger percentage of the inbreds than of the outbreds showed defects of one kind or another. Their average litter weight was 482 pounds at 6 months of age.

Pigs of the second group, which were from inbred dams and by inbred sires of other lines, were remarkably uniform in type and performance. They made faster gains than those in any of the other groups. In gains per unit of feed, they were surpassed only by the pigs from dams that were the result of crossing two inbred lines. A higher percentage of them than of the pigs from unrelated outbred parents lived. Their average litter weight at 6 months was 1436 pounds, which, owing to fewer pigs at birth, was slightly less than that of the litters from unrelated, outbred parents.

So far as the number per litter at birth and at 6 months and so far as the gains per unit of feed were concerned, being sired by inbred or by outbred sires made very little difference in the pigs from outbred dams. Because of slightly faster gains, the litters by the inbred sires averaged 1591 pounds, whereas those by the outbred sires averaged 1484 pounds in weight at 180 days of age.

TABLE 15.—Crossing inbred lines of swine within a breed

	1 Inbred line × same inbred line	2 Inbred line × different inbred line	3 Inbred line × non-inbreds	4 Inbred line × cross of two other inbred lines	5 Non-inbreds × non-inbreds
Live pigs per litter at birth, No.	9.8	8.3	11.6	10.9	11.1
Pigs per litter at 180 days, No.	3.7	6.9	8.5	9.1	8.4
Average daily gain, birth to 180 days, lb.	0.72	1.15	1.03	1.12	0.98
Weight per litter at 180 days, lb.	482.0	1436.5	1590.8	1842.1	1484.5
Feed per 100 pounds of gain, 9 weeks to 180 days, lb	413.3	374.8	384.7	358.2	383.0

Mating boars of an inbred line to sows produced by crossing two other inbred lines resulted in more pigs saved per litter and pigs requiring less feed per unit of gain than mating either unrelated outbred or unrelated inbred animals. The pigs by inbred sires and from dams produced by crossing two other inbred lines contained fewer runts and defective individuals and also outgained those from unrelated outbred parents. Nine pigs per litter were marketed. At 180 days of age they averaged 1842 pounds per litter, or 358 pounds more than the pigs from unrelated, outbred parents. All of the pigs were fed in dry lots after they were 9 weeks of age.

Rotating inbred sires of three lines or more on successive generations of sows selected from the herd should give results, from the second generation on, almost or fully equal to those obtained from the three line cross.

W. L. Robison

Crystal Violet Vaccine for Preventive of Hog Cholera

Intradermal injections of vaccine in amounts of 0.1, 0.2, 0.4, 0.6, 0.8, and 1.0 cc. gave variable results when the pigs were later subjected to hog cholera virus inoculations. While protection was afforded in some instances, the results as a whole were erratic and no consistent correlation was noted between the amount of vaccine used and the protection that was demonstrated.

Attempts were made to afford protection against hog cholera during the period of susceptibility that follows vaccine treatment by the injection of different amount of anti-hog cholera serum shortly before, simultaneously with, or shortly following vaccine administration.

The results were unsatisfactory since, when serum was used in an amount in itself protective, there was a notable failure of the vaccine to prolong the immunity, irrespective of the relative periods at which the serum and vaccine were administered.

B. H. Edgington and A. F. Schalk

Pantothenic Acid Required by Swine

During the past few years it was observed that weanling pigs fed a yellow corn-digester tankage ration in out-of-doors paved lots frequently developed an incoordinated, stringhalt-like gait in one or both rear legs and that they did poorly. In an experiment conducted during the past year, with 48 individually fed weanling pigs

in out-of-doors paved lots, five of the eight pigs on the yellow corn, digester tankage, iodized salt, and synthetic riboflavin basal ration exhibited the incoordinated gait. Supplementing the basal ration with either 5 per cent of dehydrated alfalfa meal (17 per cent protein) or with 0.68 milligrams of pantothenic acid per pound of feed consumed reduced the gait disorder to one out of eight pigs in each case. When the amount of alfalfa meal or pantothenic acid used in the basal ration was doubled, no gait disorders appeared in any of the litter-mate pigs kept on the experiment for 19-20 weeks; that is, until they attained market weight.

These results indicate that pantothenic acid, a factor of the vitamin B complex, is essential in swine nutrition. This is in accord with the findings of other research workers. Further work will be required to determine definitely whether pantothenic acid is the only factor involved in the prevention of the incoordinated gait.

R. M. Bethke, T. S. Sutton, and C. H. Hunt

POULTRY

Requirements of Meat Scraps, Fish Meal, and Dried Whey to Supplement Soybean Oil Meal in a Ration for Egg Production and Hatchability of Eggs from White Leghorn Pullet Layers

The four special dietary supplements well recognized as more necessary for the production of hatchable eggs than for egg production are meat scraps or fish meal, milk products, and vitamin A and D feeding oil or their substitutes.

In view of the increasing use of plant protein supplements for feeding layers, the minimum requirements of meat or fish and milk products to supplement soybean oil meal for economical egg production, as well as the additional requirements for the production of hatchable eggs, have become a pertinent question. To secure information on this question, an experiment was started in 1943 and completed in 1944. Twelve groups of 45 trap-nested White Leghorn pullets each were used. Their eggs were pedigree hatched for 10 weeks between January and June.

The basal ration, with soybean oil meal as the principal source of protein supplemented with 2.5 per cent dried whey, failed to meet the requirements either for egg production (151 eggs per bird for 44 weeks) or for hatchability of the eggs (52 per cent). Although the addition of 2 per cent of 50 per cent protein meat scraps improved both egg production (165) and hatchability (76

per cent), 4 per cent of the meat scraps was necessary for good hatchability (82 per cent). Contrary to this, 2.5 per cent of dried whey and 2 per cent of menhaden fish meal were sufficient to produce good hatchability (81 per cent) of the eggs. Other additions of 6 and 8 per cent of meat scraps and 4 and 6 per cent of fish meal did not improve egg production or hatchability.

When the basal ration was supplemented with 5 per cent of dried whey instead of 2.5 per cent, there was an improvement in hatchability (75 versus 52 per cent). With the addition of only 2 per cent of meat scraps, the 5 per cent of dried whey yielded satisfactory hatchability (85 per cent).

In this experiment with White Leghorn pullet layers, the basal ration supplemented with 16 per cent soybean oil meal and 2.5 per cent dried whey failed to meet the requirements either for egg production or hatchability of the eggs; whereas, the basal ration with 10 per cent soybean oil meal, 2.5 per cent dried whey, and 4 per cent of meat scraps (50 per cent protein) did. Likewise, the basal ration with 12 per cent soybean oil meal, 2.5 per cent dried whey, and 2 per cent menhaden fish meal yielded satisfactory results. It appears that these levels of meat scraps, menhaden fish meal, and dried whey are near the minimum requirements of White Leghorn pullets for the production of eggs of good hatchability.

D. C. Kennard and V. D. Chamberlin

Free-choice Versus Limited Feeding of Whole Grain to White Leghorn Pullets

The free-choice feeding of whole grain has become a popular method of feeding layers during the past 10 years, chiefly because of the lower cost of feeding more whole grain and less ground grain or mash.

In the experiment completed in 1944, the one group of layers which received the free choice of whole corn and oats and the 24 per cent protein mash and the other group which received a 32 per cent protein mash laid practically the same number of eggs (156 and 154 per bird) during 44 weeks. The third group whose grain was limited (to 16.5 per cent protein of the total feed intake) was 176 eggs per bird. The percentage protein of the total feed intake of the free-choice groups was 15.0 and 15.7, respectively, which was hardly sufficient for best results. The greatest reflection, however, of too much grain and too little mash was evident by the losses from cannibalism (pickouts); these losses were 18, 4, and 0 per cent, respectively. The results of this experiment are pretty much in line with similar preceding experiments.

Limited grain feeding deserves special consideration by poultrymen who experience undue trouble among the layers from feather picking and cannibalism. Also, limited grain feeding will often prove advantageous in the feeding of yearling or older hens, heavier breed layers, and in the production of eggs of good hatchability.

D. C. Kennard and V. D. Chamberlin

Good Returns from Pasturage for Chickens

In response to the wartime feed scarcity, a special pasturage ration was designed by this Station for the growth of chickens when or where good pasturage is available. This ration has been used successfully for the growth of 2,000 to 3,000 pullets each year at the Station during the past 5 years. Only such feedstuffs not adequately provided by good pasturage were included in the pasturage ration. This simple, less expensive ration (without milk products, alfalfa meal, and vitamin supplements) enables poultry raisers to realize substantial savings in feed and cost of raising their chickens.

Fig. 20.—Chicks and growing pullets generally thrive best in colony houses on a good range.

Since the pasturage ration proved so satisfactory, it evidently provided more than the minimum requirements for the normal growth of chickens having access to good pasturage. This gave rise to the question, "Just how much can pasturage be depended upon for the growth of chickens, and will whole grain and pasturage alone serve the purpose?" This became a pertinent question with poultry raisers in 1942 and 1943 during the wartime scarcity of protein supplements.

GROWTH OF WHITE LEGHORN PULLETS ON FREE RANGE AND PASTURAGE

To secure information on the preceding question, experiments were conducted with the growth of White Leghorn pullets in 1943 and 1944. In each experiment 200 7-week-old pullets were started on whole grain without mash and continued on this limited ration until they were ready to lay. A similar number of the same kind and age of pullets received the special pasturage mash and whole grain. Both groups had free range of woodlot and hedgerow pasturage of bluegrass, orchard grass, broadleaf plantain, dandelion, etc., and a nearby cornfield—a typical combination available on many Ohio farms.

The results of the experiments were practically the same both years. The pullets that received the pasturage mash were a little heavier when housed and started to lay 2 weeks earlier than those that received whole grain and pasturage without mash. However, these pullets, upon receiving the laying ration, soon caught up in body weight and egg production and laid as many eggs during the remainder of the year. The mortality of both groups was practically the same.

From the standpoint of egg production, body weight, and mortality of the pullets as layers, there was no indication during either year that the White Leghorn pullets were ill affected as layers from having been raised on whole grain, free range, and pasturage after the first 7 weeks.

It should be emphasized, however, that these experiments were conducted with comparatively small flocks of pullets and that the pullets had unlimited range comparable to the "run of the farm".

LIMITED RANGE EXPERIMENT WITH THE GROWTH OF RHODE ISLAND RED PULLETS

A third and different type of range and pasturage experiment was conducted on the growth of Rhode Island Red pullets. Contrary to the growth experiments with White Leghorn pullets, the Red pullets were confined to a limited range (200 pullets per acre) of Ladino clover.

Beginning June 1, 260 14-week-old Rhode Island Red pullets were confined to 1.3 acres of Ladino clover and were fed only whole wheat (no mash) until September 13. In an adjoining Ladino clover range there were 700 pullets of the same kind, age, and number per acre of range which received whole wheat and the pasturage mash. The average weight per bird of these pullets was 1.45

pounds greater (5.01 versus 3.56 pounds) on September 1 than that of the pullets which received no mash. What is more, there were twice as many culls (23 per cent) among the pullets that received no mash and the remainder of the pullets started to lay 6 weeks later.

Here the value of range with its bugs, insects, worms, etc., was brought into sharp contrast with that of good pasturage. The Ladino clover would have provided good pasturage for twice the number of pullets, but it was the limited range which failed to supply sufficient insects, bugs, and worms to supplement the pasturage and whole wheat. The pasturage mash, of course, was designed particularly as a substitute for the range part of the diet when the chickens have ample pasturage or green feed available.

Although in the two experiments, White Leghorn pullets made satisfactory growth after the first 7 weeks on free range, pasturage, and whole grain without mash, only a comparatively small number of pullets having the "run of the farm" could be expected to make satisfactory growth without mash. Therefore, the safer procedure is to supplement the range with a suitable mash.

The one experiment with the growth of Rhode Island Red pullets definitely indicated the limitations of pasturage and the need for the special pasturage mash, even with the best of pasturage (Ladino clover) for a larger number of pullets confined to a limited range.

D. C. Kennard and V. D. Chamberlin

Layers Must Have Their Calcium and Vitamin D

Vitamin D and calcium have long been recognized as among the dietary essentials for egg production. A recent experiment by this Station with rations deficient in these essentials have contributed some definite results about the behavior of the layers and egg production not heretofore available.

The experiment was conducted with four groups of 50 Rhode Island Red pullets. One group received the complete control ration; another received the same ration without the calcium supplement; a third group received the control ration without the vitamin D feeding oil; and a fourth group received the control ration without vitamin D feeding oil until February 16, after which this group received vitamin D feeding oil (the control ration).

The egg production of the group without oyster shell fell from 45 to 20 per cent within 2 weeks. This group laid only one-half the number of eggs per bird as the control group which continued to

receive the shell during the 46 weeks of the experiment. The percentage of weak-shelled eggs was 76 versus 36 for the control group. Both groups received granite grit. The control group ate 19 pounds of granite grit during the 46 weeks; whereas, the group without oyster shell ate 900 pounds in their response to nature's urge to overcome their calcium starvation. This would seem to be the answer to the question, "Do layers voluntarily consume sufficient shell material when it is kept before them?"

On the other hand, vitamin D is necessary to enable the layer to assimilate calcium. Vitamin D, contrary to calcium, is fat soluble and a reserve supply is widely distributed throughout the bird's body, especially range-raised pullets. Thus, the ill effects of a vitamin D-deficient ration may not become evident until 2 or 3 months later. Consequently, true to form, the egg production and strength of egg shells of the two groups without vitamin D feeding oil was comparable to the control (complete) ration from October 1 to January 5. After January 5 both groups dropped to 25 per cent egg production (control group 39 per cent) with 54 per cent of weak-shelled eggs (control group 6 per cent). Vitamin D feeding oil was added to the feed of one of the groups without vitamin D since October 1 and this group promptly responded with increased egg production from 25 to 54 per cent within 2 weeks. What is more, during these 2 weeks, the eggs changed from weak-shelled eggs with a breakage of 71 per cent to strong-shelled eggs with a breakage of only 15 per cent. Also, the eggs increased 5 ounces per dozen in weight.

The one group which was continued without vitamin D feeding oil remained in low production of weak-shelled eggs until the 1st of April, when warmer weather and longer days permitted them to receive the beneficial effects of exposure to the direct rays of the sun (a source of vitamin D). After April 1 the egg production and shell strength of the eggs from this group were nearly equal to the control group and that of the other group which received vitamin D feeding oil after February 16.

Vitamin D deficiencies may be due either to an actual deficiency in the mash or to the layers eating too much grain and too little mash since these provide ample vitamin D only when a sufficient amount is consumed. Deficiency of vitamin D can often be avoided by limited whole grain feeding instead of free-choice or over-feeding of whole grain.

D. C. Kennard and V. D. Chamberlin

A Device for Testing the Breaking Strength of Egg Shells

Eggs to be marketed must have sufficiently strong shells to withstand the usual shocks encountered during handling and transportation. The strength of egg shells is determined by the hen's diet, rate of egg production, breeding, state of health, and weather conditions.

The best measure of shell strength is a shock test, whereby the eggs are subjected to breakage conditions similar to those encountered in handling and transporting operations. The device herewith described for testing the shock strength of shell eggs was designed to meet these needs.

The shock test of egg-shell strength is based upon a given fixed arbitrary standard which will permit 85 to 95 per cent of the eggs of normal strength to pass the test without breaking. All eggs to be tested are subjected to this fixed standard.

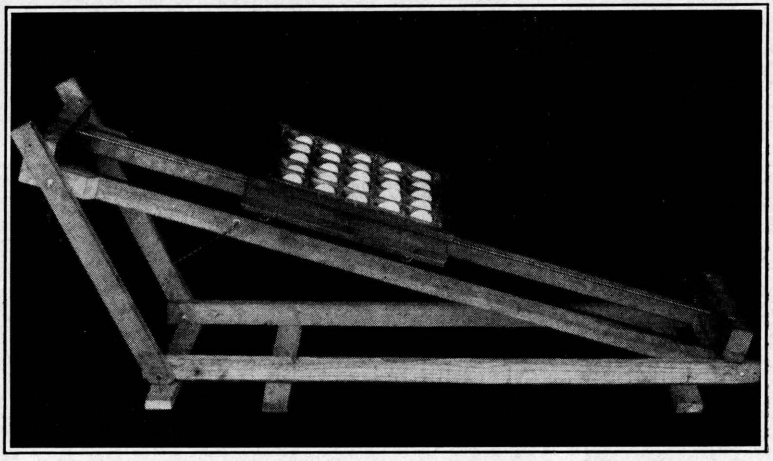
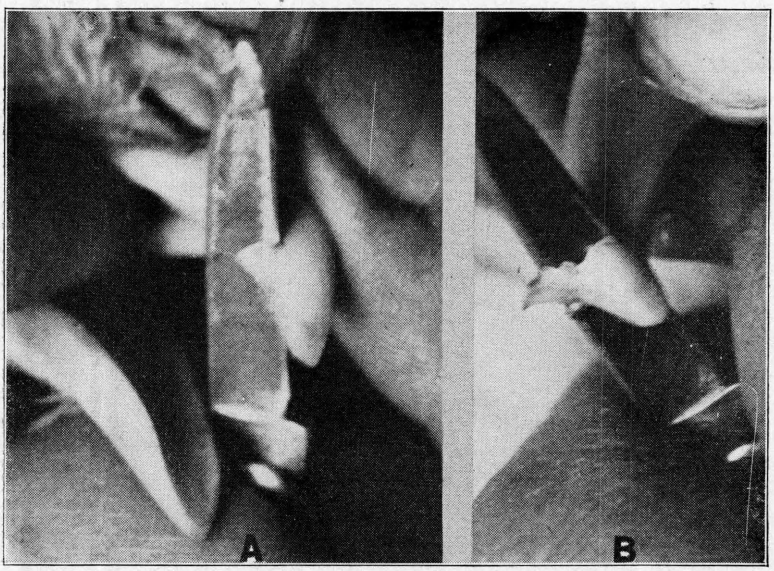


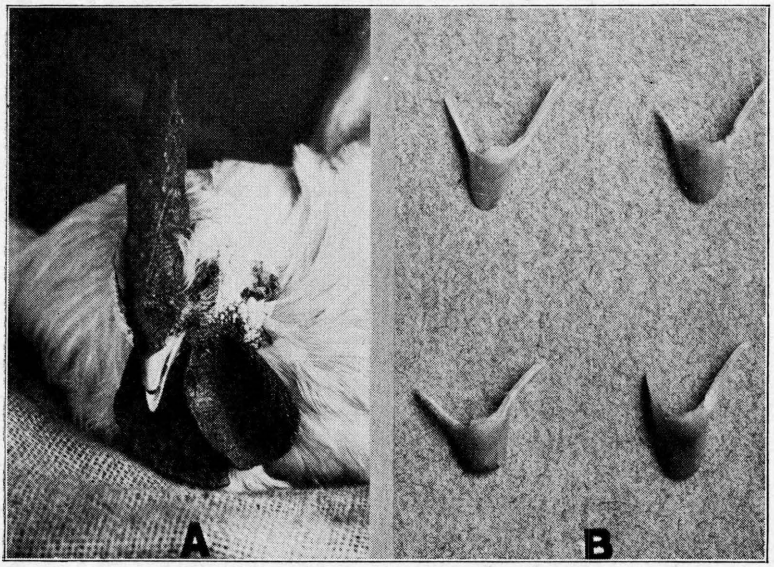
Fig. 21.—A device for testing the shock strength of egg shells

The design and construction of the device is comparatively simple as is evident from the photograph. The device serves a valuable purpose for use in experimental projects in which the strength of egg shells may be affected by the diet and other factors. Examples of the type of data that can be secured by the use of the device can be observed in connection with the discussions of sources of calcium for egg shell formation and the strength of egg shells as affected by a deficiency of calcium or vitamin D in the diet of the layers.

D. C. Kennard and V. D. Chamberlin



A—The first cut at one side of the beak
B—After a slight prying and pulling against the flat side of a knife blade, the tip of the beak is removed.



A—Cockerel after removal of tip of upper beak
B—Tips of upper beaks after removal

Fig. 22.—Debeaking chickens

Debeaking to Prevent or Control Cannibalism

Cannibalism is often a serious problem with layers confined indoors. A method of removing the upper beak by the tearing process[5] was discovered by this Station in 1928. Many poultrymen have found this their best standby when cannibalism starts in the laying flock.

Removal of the upper beak by the tearing process is a simple, rapid procedure which avoids the need or expense of any mechanical equipment except a sharp pen knife. About ¼ inch of the upper beak can be removed without bleeding at the rate of 150 to 250 per hour.

Of special interest to poultrymen is the effect of debeaking upon egg production. Observations on this point were made during three different instances this past year. The egg production for the 2 weeks previous to debeaking was compared with that of the 2 weeks following debeaking. These observations revealed no noticeable difference in egg production after the layers in 50 to 60 per cent egg production were debeaked. In one instance, the feed consumption of layers having the free-choice of whole corn, whole oats, and a 24 per cent protein mash was recorded before and after debeaking. Upon debeaking the layers on February 14, they ate practically no corn the day after, about a third the usual amount the second day, and the usual amount the third day. The consumption of oats was less for 2 days; the mash consumption was 30 per cent less for 2 days, after which it was as usual. Despite the fact that these layers ate but one-third their usual total feed during the 2 days after they were debeaked, they continued to lay as before.

Loss of egg production from the disturbance which attends cannibalism in a laying flock is more to be feared than that from debeaking. Debeaking renders the birds harmless to attack each other for 4 to 6 weeks, during which time they generally forget the pernicious habit and no further trouble is experienced. In some instances, it may be necessary to remove the beaks a second time.

It should be emphasized that clipping or cutting the beaks is not effective because a sufficient removal of the beak cannot be made without too much loss of blood.

[5]Described and illustrated in the Station's Bimonthly Bulletin No. 224, September-October, 1943.

D. C. Kennard and V. D. Chamberlin

Sources of Calcium for Layers

A suitable source of calcium is as essential as any part of the ration for layers. The necessary calcium for egg shells is generally provided by keeping oyster shell (or other suitable shell material) or high-calcium limestone grit before the layers at all times. Under wartime conditions, many poultrymen have experienced difficulty in obtaining oyster shell and were obliged to change to limestone grit, which they were not accustomed to using. Poultrymen then began to ask whether limestone grit was as good as oyster shell. The answer, according to the Station's experiments in 1943 and 1944, is "yes" and "no". "Yes", if the limestone grit is of the poultry feeding grade (P. F. G.); i. e., 90 per cent or more calcium carbonate. "No", if the limestone grit is from a low-calcium, high-magnesium (dolomitic) limestone.

The use of high-magnesium limestone grit greatly reduced egg production and the eggs were very weak shelled—63 per cent when subjected to the breakage test versus 15 per cent from hens having oyster shell and 19 per cent from those having P. F. G. limestone grit.

Unfortunately, much of the limestone in Ohio is high in magnesium and not suitable for feeding poultry. However, a high-calcium, Ohio limestone grit was used and proved as satisfactory in the Station's experiments as did oyster shell or an imported calcite grit. Recently, a new shell material (Coquina shell) has made its appearance in Ohio. Thus far, this material has proved satisfactory in the Station's experiments.

Inasmuch as limestone grits for poultry feeding do not come under the State's Feed Inspection Service, poultrymen need to exercise care to make sure they purchase only limestone grit of poultry feeding grade.

D. C. Kennard and V. D. Chamberlin

Dried Fermentation Solubles Versus Milk Products in Chick Rations

Milk in some form has generally been conceded to be a valuable, if not almost indispensable, ingredient in chick rations because of its mineral, good-quality protein, and water-soluble vitamin (riboflavin and associated factors) content. Since minerals and proteins, and especially riboflavin and associated vitamins, can be obtained from other sources at less cost than from milk, investigations were carried out to determine whether dried fermentation solubles of guaranteed riboflavin content could replace milk products in practical chick rations, and, if so, under what conditions.

The results of the several experiments conducted under battery conditions showed that dried fermentation solubles of guaranteed riboflavin content could be used as a replacement of milk products providing 2 to 5 per cent of fish meal was included in the ration in which soybean oil meal served as the chief source of supplemental protein. In other words, when the ration contained 2 to 5 per cent of fish meal and a sufficient amount of dried fermentation solubles to make the ration adequate in riboflavin, no improvement in growth, livability, or feed utilization was observed when milk products were included in the ration. On the other hand, milk products increased the value of similar rations in which either soybean oil meal or a combination of soybean oil meal and meat scraps served as the only source of supplemental protein.

R. M. Bethke and D. C. Kennard

Fruits

APPLES

The Melrose Apple

The Melrose apple, recently introduced by the Ohio Experiment Station as a result of its breeding program, appears so promising that it will probably become a standard, late-harvested, late-keeping commercial variety. A very favorable report has already been received from the test orchard of the United States Department of Agriculture at Beltsville, Maryland. The Melrose apple is grown there on grafted trees and is reported to be well colored and of "excellent" quality. At Wooster, the fruits are well covered with an attractive carmine and has a live yellow under color. The fruits are roundish-oblate in shape and larger in size than Jonathan. The fruits also surpass Stayman Winesap in dessert quality and they remain firmer under storage, where their condition continues excellent until April. The flesh is fine, firm but not tough, crisp, juicy, and of excellent flavor.

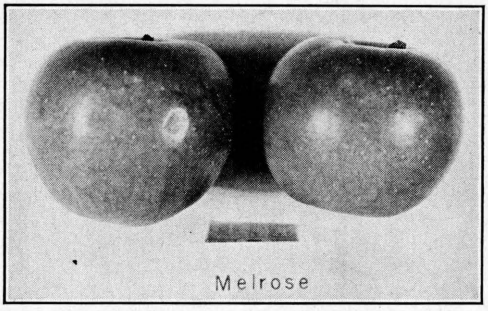


Fig. 23.—The Melrose apple shows great promise.

This variety is the result of a cross between Jonathan and Delicious. Its many excellent qualities indicate that it will supplement Stayman Winesap and Rome Beauty as a standard commercial variety. The time of picking precedes Stayman Winesap by a few days, as a rule, and occurs at least a week after Jonathan.

The variety is already on trial at several experiment stations and is being introduced into the nurseries in order that a supply of trees may soon be available.

F. S. Howlett

Red Strains of Apples

A number of red strains of some of the standard varieties of apples are fruiting in the Ohio Experiment Station orchards.

Comparisons between these red strains and the original variety from which they were derived have been made over a period of several years. These observations have included color of fruit, date of bloom, time of picking, behavior in storage, sugar and acid content, and quality of fruit.

Starking and Richared (red strains of Delicious), Staymared and Blaxtayman (red strains of Stayman), and Gallia Beauty (a red seedling of Rome Beauty) have all been under observation at the Station for 10 years or more.

The red strains are definitely superior in color to the original varieties. The date of full bloom is the same as the parent varieties. The common indices used to measure maturity, such as the pressure test of the fruit, under color, and adherence to the tree, all indicate that the fruit of the red strains should be harvested at the same time as the original varieties. Sugar and acid determinations and flavor preference, as measured by the opinions of consumers, also showed that these red strains should not be harvested before the original varieties.

These red strains now give promise of supplanting the old standard sorts, but growers are warned that harvesting the red strains prematurely will result in fruit of inferior quality.

C. W. Ellenwood

Apple Growers' Report Costs

A group of 136 representative commercial orchardists in 49 counties in Ohio reported their costs of growing, harvesting, packing, and storing apples in 1943.

Analysis of these reports revealed that overhead, production, and harvesting costs (before packing) averaged $1.66 a bushel for U. S. No. 1 apples. Grading, packing, and storage costs averaged over 79 cents a bushel, bringing the aggregate cost, exclusive of marketing expense, to $2.45 a bushel for apples properly packed in a new, round, stave bushel basket and stored in a commercial cold storage to the end of the season.

Costs per bushel in 1943 probably were unusually high, since they were influenced by a very short crop of apples in Ohio and by wartime factors such as high wage rates, scarcity and relative inefficiency of labor, and high cost of materials and supplies. However, some expenses probably were deferred to later years because of these conditions. Data were not available to permit comparisons with costs in these same orchards in earlier years.

Costs reported by these growers ranged from $1.28 to $9.19 a bushel, inversely related to the number of bushels produced per acre. Low yields were accompanied by high cost per unit however favorable the location and layout of the orchard or however efficient and economical its operation.

C. W. Hauck

GRAPES

Soil Factors Which Limit the Yield of Grapes in Ohio

There have been many reports from grape growers during the past 20 years indicating a considerable decline in the yield of grapes on the islands and along the Lake Shore of north central Ohio. For this reason soil studies were made in an attempt to

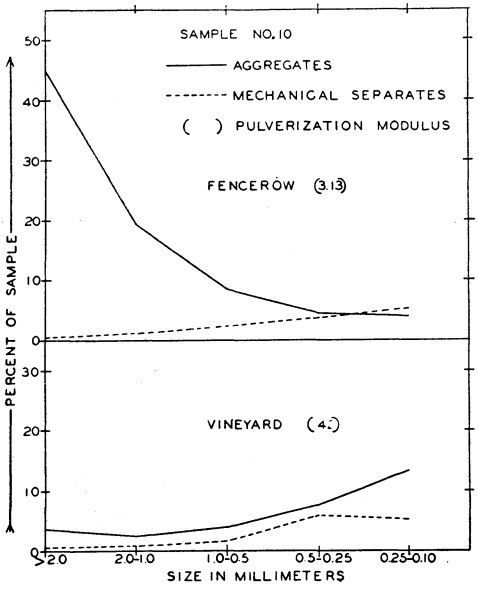


Fig. 24.—Aggregation in tilled vineyard and adjacent untilled fence-row soil.

determine in what fundamental way the surface soil stability, as revealed by aggregation, and the surface soil fertility (chemical analysis) have been altered in some representative commercial vineyards in north central Ohio.

Results reveal the destruction of a favorable surface soil aggregation and consequent unfavorable aeration and water penetration (Fig. 24). Chemical analysis indicates a serious loss of total nitrogen which is closely related to organic matter. (Fig. 25). These unfavorable conditions have resulted from long continued and intensive tillage practices.

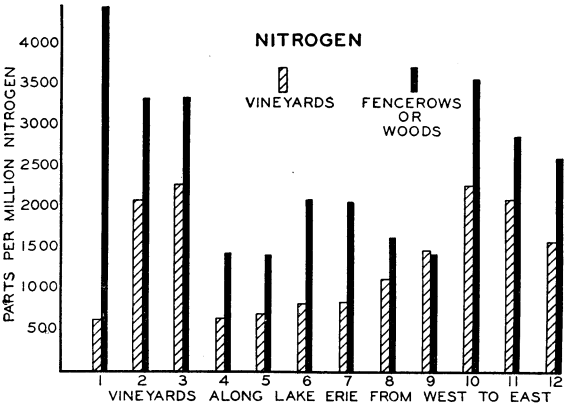


Fig. 25.—Total nitrogen content of the surface soils in vineyards and adjacent undisturbed fence-row or woods soils.

A minimum of tillage consistent with optimum growth of vines and the use of moderate applications of manure or fertilizer with cover crops would go far toward remedying the unfavorable cultural situation existing at present in this area. Therefore, the recommended cultural practices should increase the grape production per acre.

I. W. Wander

PEACHES

Cultural Systems for Peaches

An experiment was started in 1935 to compare the effects of cultivation with sod and sod plus straw mulch on the growth and yield of South Haven peach trees. The cultivated plots were seeded to a summer cover crop (usually soybeans) in July and to a winter cover of rye in October. All trees received nitrogenous fertilizer, regardless of the cultural system being followed.

Water did not seem to be a limiting factor in any of the treatments. The trees grew satisfactorily under all the treatments in so far as increase in trunk circumference is concerned. (Fig. 26). It should also be noted that except for the plots receiving manure, the average yields during 1943 and 1944 were closely proportional to the trunk circumference of the trees.

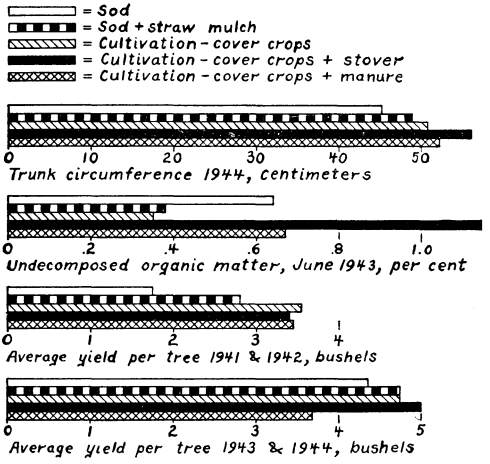


Fig. 26.—Undecomposed organic matter in silt loam soil and trunk circumference and yield of peach trees growing under different cultural systems on this soil.

The yields and tree growth did not show a correlation with the organic-matter content of the soil. This experiment was carried out on Wooster silt loam soil on a site not susceptible to erosion; hence, the conclusions reached would not necessarily apply to other soils and sites. The most important limiting factor in the sod plots seemed to be nitrogen.

Wesley P. Judkins

PEARS

Old Home Pear as a Blight-resistant Framework for Bartlett and Other Pear Varieties

Utilization of the Old Home pear as a framework for blight-susceptible varieties has greatly reduced the loss of trees from fire blight in the orchards of the Experiment Station at Wooster. During the last 8 years (1937-1944), only one tree out of the 49

trees removed because of blight involved this Old Home stock. In that case, Bosc was top-worked on Old Home. Bosc top-worked on other varieties such as Kieffer and Bartlett resulted in eight losses.

Fig. 27.—Old Home pear tree top-worked to commercial pear variety. Station orchard

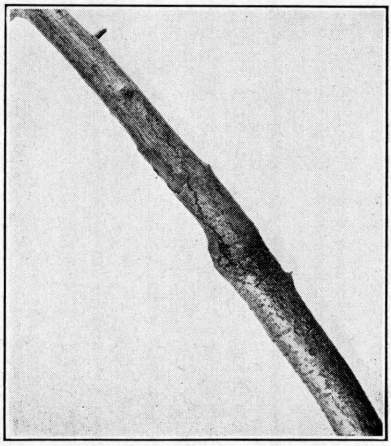


Fig. 28.—Portion of scion variety and intermediate Old Home pear stock showing fire blight canker on scion variety extending to point of union with stock. Station pear orchard

In this test the various pear varieties were budded or grafted on the laterals of Old Home 8 to 16 inches from their point of origin on the trunk. Eight to 16 laterals were so top-worked on each tree. Although Old Home is not itself immune to blight and does not increase the resistance of the top-worked variety, its use seems to result in less trunk injury and girdling. Other precautions against fire-blight injury must be observed; namely, maintenance of the trees in sod, withholding nitrogen-carrying fertilizer, and a constant observation of the trees during the growing season.

Old Home is an European variety producing fruit of no commercial importance, but it has been utilized for some time on the West Coast and in the Pacific Northwest for the purpose described here. At present this stock is available in only two western nurseries, but trees may shortly be obtained in the East as well.

F. S. Howlett

RASPBERRIES

Cultural Systems for Raspberries

The use of straw mulch around red and black raspberry plants has increased yields over those plants receiving clean cultivation. The largest yields were secured from canes having a large diameter. Experimental plots producing small canes gave low yields per acre even though large numbers of the small canes were present. The important effects of mulch are: (a) conservation of soil moisture, (b) prevention of erosion, (c) control of weeds, (d) reduction of the heaving of plants resulting from freezing and thawing of soil in late winter and spring, and (e) a lower and more uniform soil temperature in summer.

Fig. 29.—Latham raspberry plants heaved from the ground in a cultivated plot on Wooster silt loam soil.

Wesley P. Judkins

DISEASE CONTROL

Apple Scab Spray Tests

Apple-scab tests conducted at Wooster during the summer of 1943 again indicated that flotation-sulfur paste was equally as effective as lime-sulfur. This was true even when flotation sulfur was used in the pre-bloom, as well as post-bloom, sprays, provided that the sprays were correctly timed in accordance with rain periods and scab spore development. During the seasons of 1942

and 1943, Fermate (ferric dimethyl dithiocarbamate), used at the rate of 2 pounds per 100 gallons of water in the pre-bloom, and 1½ pounds in the post-bloom, sprays, controlled scab equally as well as flotation sulfur and lime-sulfur.

Lime-sulfur has been shown to reduce leaf area and apple yields over a period of years and frequently has caused fruit russetting and injury; whereas, flotation sulfur and Fermate in the tests conducted during 1942 and 1943 caused no appreciable reduction in leaf size and in fruit yields. Furthermore, fruit finish was excellent.

H. F. Winter and H. C. Young

Cherry Leaf-spot Spray Tests

Spray tests conducted in a commercial Montmorency cherry orchard at Clyde, Ohio, in 1942 and 1943 again showed that fixed copper compounds, at the rate of 1½ pounds of a 50 per cent copper material per 100 gallons of water, were most effective in controlling the leaf-spot disease. Sulfur fungicides, including lime-sulfur, were decidedly inferior to the copper materials. Two organic materials, HE-175 and Fermate, were not sufficiently effective to warrant their use for the control of cherry leaf spot. Fermate controlled the disease well until harvest, but it failed in the long period after harvest. Bordeaux 1-2-100 was as effective in controlling leaf spot as the fixed coppers but caused slightly more injury. Bordeaux formula stronger than 1-2-100 caused excessive foliage injury and markedly reduced fruit size. To avoid excessive copper injury with the fixed copper materials, it was found necessary to add 3 pounds of fresh hydrated lime to each 100 gallons of spray. The addition of Orthex spreader, at the rate of 1 pint per 100 gallons of spray, significantly increased the effectiveness of the Tribasic copper sulfate and copper oxychloride materials.

H. F. Winter and H. C. Young

Laboratory and Greenhouse Testing of Fungicides Against Apple Diseases

During the winter of 1943-44, 15 different organic materials were tested in the laboratory and greenhouse to determine their possible value as fungicides for field spraying. It was particularly desired to find a material which would be effective in controlling the apple bitter rot disease. Bordeaux mixture, which is generally recommended for bitter rot control, commonly causes serious injury to apple fruit and foliage.

Laboratory studies consisted chiefly of slide germination tests employing the spores of three pathogenic fungii, *Glomerella cingulata*, *Sclerotinia fructicola*, and *Colletotrichum phomoides*. Greenhouse studies were confined to testing the more promising materials for injury to various plants grown in the greenhouse.

Of the 15 materials tested, four were outstanding in their ability to inhibit the germination of fungous spores. One of these, Sulfasan (an organic sulfur material) was found to be very injurious to plant foliage and was discarded. The other three; namely, Fermate (ferric dimethyl dithiocarbamate), Methasan (zinc dimethyl-dithio-carbamate), and Puratized N5-X (phenyl mercuri triethanol ammonium lactate), were found to cause no injury on the plants tested when used at fungicidal concentrations. The above named materials had previously been tested and used to some extent as fungicides but had not been given adequate trial for the control of apple bitter rot. Since all three were highly toxic to spores of the bitter rot fungus, *Glomerella cingulata*, and appeared to cause no injury to apple foliage, it was concluded that Fermate, Methasan, and Puratized N5-X showed sufficient promise to warrant orchard trials for the control of bitter rot and other apple diseases.

H. F. Winter and H. C. Young

INSECT CONTROL

The Oriental Fruit Moth

The 1943 infestation of oriental fruit moth, *Grapholitha molesta* (Busck), in ripe peaches was the most severe experienced for many years in the northern peach-growing sections of Ohio. Records taken at peach harvest in 31 orchards showed an average visible infestation in Elberta and Elberta-season varieties of 23.4 per cent, as compared with an average of 7.1 per cent for the three preceding seasons. No records were taken on concealed injury, but previous data would indicate an accompanying, although not necessarily proportionate, increase in this category. The infestation in later fruit was preceded by unusually heavy damage to pre-Elberta-ripening varieties, such as Golden Jubilee, Rochester, Halehaven, South Haven, and others. Previous observations have indicated that injury to these varieties is, as a rule, relatively unimportant during most seasons. However, records from 13 northern Ohio orchards indicated that an average of 15.0 per cent of the fruit was visibly injured in 1943.

Several factors appear to have contributed to this substantial increase in fruit-moth damage. First, the season was unusually wet during the months of May, June, July, and August. The rainfall for this period in six northern Ohio counties was 2.09 inches above the 50-year average, as compared with an excess of 0.77 inches during 1942 and a deficit of 0.70 inches for the same period in 1941. The excess rainfall promoted development of succulent twig growth which has been shown to be directly correlated with the number of infested terminals per tree. As a result, the duration of optimum conditions for terminal infestation was materially lengthened, and larvae were present in the twigs in substantial numbers for approximately 1 month later than had been observed during the preceding season. Second, a significant decrease in the effectiveness of parasites, as measured by the degree of parasitization of twig-infesting larvae, was observed during the months of June and July. Parasitization records from 20 orchards of northern Ohio indicated that an average of 24.5 per cent of the first-brood and 48.0 per cent of the second-brood twig-infesting larvae were parasitized. With the exception of the 1942 season, which was only slightly lower, this was the lowest average first-brood parasitization recorded during the past 12 years. However, without exception, it was the lowest for second-brood larvae for the same length of time. Third, fruit moth was abnormally abundant and the crop light; therefore, as might be expected, a high percentage of the fruit was infested at harvest.

The braconid, *Macrocentrus ancylivorus* Roh., is the dominant species of the fruit-moth parasites in northern Ohio, but its establishment appears to be rather definitely limited to that part of the State. However, the presence of the strawberry leaf roller, *Ancylis comptana fragariae* (W. & R.), which is also attacked by this parasite in southwestern Ohio, has enabled it to become established in this area. Elsewhere in central and southern Ohio *M. ancylivorus* can be recovered during the year it is introduced but decreases in numbers and usually disappears during succeeding seasons.

Experiments have shown that additional liberations of relatively small numbers of this parasite in orchards where it is definitely established produce little or no increase in subsequent parasitization. Further experiments in liberating larger numbers of parasites than heretofore used will be necessary to determine to what extent the level of twig-larval parasitization can be increased.

Control of the fruit moth by means of its natural enemies (larval parasites in particular) appears most effective when a high degree of twig-larval parasitization is maintained and when conditions are unfavorable for development of the insect. For example, during some seasons with normal or subnormal rainfall in May, June, July, and August the peach terminals harden early and, as a result, natural larval mortality is increased. During other seasons, such as 1943, when there is an excess of growing-season rainfall, succulent twig growth is promoted and the twig-larval population of the fruit moth is not handicapped. Obviously, a larger potential fruit-infesting population can develop during such seasons. Control of the insect does not appear to depend entirely upon the activity of parasites but upon a combination of the effect of ecological factors plus parasitization. During some seasons the effect of these factors and parasitization appears cumulative with reference to satisfactory control; during others antagonistic.

Norris D. Blackburn

Comstock's Mealybug (*Pseudococcus comstocki* (Kuw.)), a New Pest of Ohio Apples

Comstock's mealybug was brought to this country from Japan sometime prior to 1918. In 1921-22 it appeared as a serious pest in Virginia, where it attacked the umbrella catalpa. At that time it was found feeding on apple also, but it was not until 1932 that it became a pest of prime importance on this host.

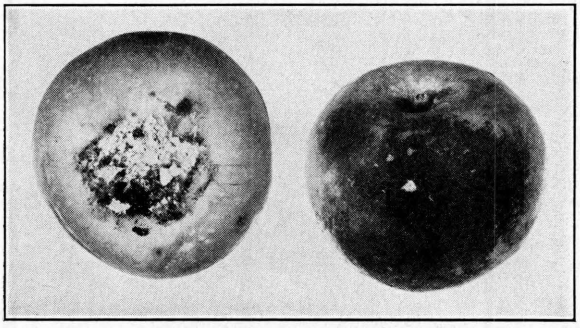


Fig. 30.—Apples damaged by Comstock's mealybug
Left—Cluster of mealybugs on calyx of fruit.
Right—Sooty mold thriving in mealybug discharge on surface of fruit.

In Ohio, this mealybug was collected on umbrella catalpa about 1920 and its occurrence on this host has been widespread. In 1939 specimens of mealybugs attacking apple were received from the

orchard of Cecil McCown at Proctorville, Ohio. These were later identified as Comstock's mealybug. The principal injury to apple is caused by the dropping of honeydew on the fruit, followed by the growth of a black fungus. This seriously discolors the fruit and is practically impossible to remove by washing, even in the most effective machines. Frequently, rots develop under the coating of black fungus.

Trials of different spray materials were made during the fall of 1939 and in 1940. With the exception of Loro, no material with any degree of effectiveness was found. Even in the case of Loro, at least three applications per season were needed for control and under the economic situation of that time, this was not a practical remedy. Tests of many dormant sprays were made in the spring of 1940 but, again, no effective material was found. Since extensive experimental spray programs in Virginia had given negative results also, it was decided to abandon this type of work and to concentrate on a program of control by parasites.

Through a cooperative agreement with the Bureau of Entomology and Plant Quarantine, parasites of the Comstock's mealybug were secured from the Entomological Laboratory at Charlottesville, Virginia. The first liberations were made in the late summer of 1940 when about 3,000 *Clausenia* sp. and three colonies of *Allotropa* sp. were placed in the McCown orchard. Collections made on August 2, 1941 showed that both species had survived the winter and had reproduced, though in very small numbers.

Additional liberations of parasites were made in August and September of 1941. During this period the species released included *Leptomastix* sp., *Pseudophycus* sp., and also additional numbers of *Clausenia* and *Allotropa*.

Further liberations were made in June and August of 1942, with *Allotropa* sp. and *Pseudophycus* sp. as the main species involved. This was the last year of parasite introductions.

Although parasites were recovered from every collection of mealybugs made during 1940 and 1941, it was not until midsummer of 1942 that significant increases in parasitization were noted. Collections made on August 18 showed that 15 per cent of all mealybugs were parasitized. This was followed by a tremendous increase in parasitization during the autumn months, when 92 per cent of all mature mealybugs were killed. This figure represented conditions not only in the McCown orchard but also in other orchards in the community that had become infested with mealybug but in which parasites had not been liberated.

This increase in parasitization plus the mortality caused by a fungous disease was so effective that no commercial damage by mealybug was found in 1943 and 1944 in any of the orchards in which parasites had been placed. At the end of the 1944 season, mealybugs could be found only with difficulty in the Proctorville area. This means that parasites also are reduced in numbers. However, it is believed that future control of the mealybug by natural means is a definite possibility.

C. R. Cutright

Peach Tree Borer on Bearing Trees and Nursery Stock

The effectiveness of each of three commercial preparations for the control of the peach tree borer was studied in a series of replicated experiments on bearing peach trees. Each material was used according to the usual recommendations. The treatments were applied in October and the trees were examined for borers the following spring. The borers per 100 trees, representing the total in five replications of each treatment, were as follows: paradichlorobenzene crystals, 59; Para-Scalecide, 20; ethylene dichloride emulsion, 0; untreated trees, 432.

The control of borers with ethylene dichloride emulsion was excellent, but brown spots, which may have been caused by the chemical, sometimes appeared in the inner bark of the trunk where the material was applied. Inasmuch as some loss of trees has been caused in Ohio by this chemical, it should be used with caution.

Previous work with paradichlorobenzene indicates that it is more effective earlier in the fall and in warmer weather than under the conditions of this experiment. No injury caused by this chemical on bearing peach trees has been observed by the writer.

Para-Scalecide, as used in this experiment, seemed more effective than paradichlorobenzene crystals. Also, work done on nursery peach trees indicates that it is safer on young trees than either paradichlorobenzene or ethylene dichloride emulsion.

The season of 1943 represented the fifth consecutive year in which experiments were conducted on nursery peach trees for the control of the peach tree borer. The work was done in nurseries at Clyde and at Perry, Ohio. The treatments were applied on August 26 and 27 at Perry and on September 17 to 21 at Clyde by pouring a measured quantity of emulsion around the base of each tree. Immediately after the application the soil in each nursery row was mounded to a depth of approximately 2 inches. The trees were examined for borers and for treatment and borer injury during November when they were being placed in storage.

Excellent results on nursery stock were obtained with Para-Scalecide diluted with nine parts water and applied at the rate of ¼ pint per tree. This material resulted in 96 per cent control of borers at Perry and 95 per cent at Clyde. Similar results were obtained by dissolving paradichlorobenzene in a summer oil emulsion. Two pounds of the chemical were dissolved in 1 gallon of the oil and diluted with 15 parts water. This was then applied at the rate of ¼ pint per tree. No treatment injury was caused by either of these materials, whereas 4 per cent ethylene dichloride emulsion injured a number of trees and killed only 70 per cent of the borers.

The data obtained indicate that the latter part of August is a more desirable time for the application than a later date because the borers are smaller and, consequently, have caused less damage. Also, the scars caused by borers have a longer period in which to heal before the trees are pulled in November.

R. B. Neiswander

GENERAL

Lespedeza in Orchard

Several years ago a young apple orchard at the CLERMONT COUNTY EXPERIMENT FARM was seeded down to Korean lespedeza. Since then the lespedeza has reseeded regularly and for a few years it made a most excellent annual growth. Then, apparently as the nitrogen content of the soil was built up, bluegrass began to appear in patches; these enlarged from year to year. In these enlarging areas, the lespedeza apparently could not compete with the vigorous bluegrass. Also, in other areas, rapid-growing annuals, such as smartweed, eventually became so vigorous that the slow starting lespedeza could not compete. The use of the mowing machine to control the weeds made possible a straggly, but not very vigorous, growth of lespedeza. Obviously, lespedeza has been of value in this southern Ohio orchard but apparently it is not to be its permanent soil cover.

M. A. Bachtell and H. S. Elliot

Scarcity of Fruit and Vegetable Shipping Containers

Shipping containers for fruits and vegetables were scarce in 1943 and 1944, due to war requirements and to shortages of factory facilities, raw material, and manpower.

Supplies of new packages fell far short of demand; the gap had to be filled by salvaging and re-using many thousands of serviceable containers after they already had made one or more trips to market. To determine the probable potential supply of used containers available to Ohio growers, a study was made of the numbers of containers of important types that may be expected to arrive in produce markets in seven selected Ohio cities during one year. These estimates dealt only with arrivals of packages containing fruits or vegetables normally used for but one shipment from farm to market.

TABLE 16.—Approximate numbers of selected types of used fruit and vegetable containers arriving in seven Ohio cities in one year*

Container	Aggregate number of containers	Per cent of total
Bushel baskets	1,401,903	7.0
Apple boxes (western)	588,924	2.9
Bushel hampers	514,700	2.6
L. A. crates	1,555,034	7.8
50-pound bags	1,196,000	6.0
100-pound bags	6,247,150	31.3
Celery crates	554,020	2.8
Orange and grapefruit boxes (southern)	2,049,600	10.3
Orange boxes (western)	1,765,325	8.8
Lemon boxes	421,600	2.1
Lug boxes (grapes and tomatoes)	1,794,800	9.0
Sweet potato crates (50-pound)	300,500	1.5
Other (10 types)	1,599,444	7.9
Total	19,989,000	100.0

*1939 in Akron, Columbus, Dayton, Toledo, and Youngstown; 1942 in Cincinnati and Cleveland.

C. W. Hauck

Vegetables

CUCUMBERS

Susceptibility of Commercial Cucumber Varieties to Bacterial Wilt Infection

Over 60 varieties of cucumbers, most of which were of commercial origin, were artificially inoculated with *Erwinia tracheiphila* in a test of comparative resistance to bacterial wilt during the summer of 1944. At least 95 per cent of 44 varieties succumbed to wilt by the end of the season following two early inoculations. Some of the least susceptible varieties were Klondike, Marketer, Mincu, Stays Green, Taxpayer, and Vickery.

J. D. Wilson

BEANS

Quick Freezing to Control Bean Weevil

Beans which had been exposed to egg deposition by the bean weevil but from which no emergence had occurred were placed in 1-pint Fonda paper containers and subjected to quick freezing for various periods of time at —1 to —5 degrees F. Following this treatment, the beans were placed in a warm room and after 48 days were examined.

It was found that no weevils had emerged from beans exposed to the temperature indicated for a period of 8 hours; in fact, infestation was established in only a few containers which had been exposed for as little as 4 hours. All samples of beans in Fonda containers which had been exposed for no more than 1 or 2 hours were infested when examined. Considerable insulation by the Fonda containers is indicated by the fact that out of another series of 12 samples exposed for 2 hours in cloth bags, five were free from weevils at the end of the 48-day period.

Germination tests made on the beans subjected to quick freezing of —1 to —5 degrees F. indicate that the germinating power was not impaired.

Because quick freezing is both efficient in control and safe from the standpoint of not impairing germination, it should provide a practical measure for protecting dried beans intended for table use or for seed from damage by weevil.

Harry L. Gui

Susceptibility of Bean Varieties to Insect Infestation

Probably all varieties of garden, field, and lima beans are susceptible in some degree to insect injury other than that done by the Mexican bean beetle. If significant variations in susceptibility exist it would be of considerable value to the gardener to be informed concerning the less susceptible sorts. In order to obtain information on this point, 83 seed samples were planted in replicated plots and exposed to field infestations during the season of 1943.

The potato leaf hopper, *Empoasca fabae* (Harris), the onion thrips, *Thrips tabaci* Lindeman, and the pale-striped flea beetle, *Systena blanda* Melsh., occurred in sufficient numbers to permit making observations in the field. The bean weevil, *Bruchus obtectus* Say, which infests the beans in the field but is destructive as a storage pest, was present also.

No differences among varieties could be observed in the amount of damage done by the pale-striped flea beetle.

Populations of leafhopper nymphs ranged from an average of less than 1 per 100 square inches of leaf area on some varieties to as many as 28 on others. Beans of the Refugee type were, in general, less heavily populated by leafhoppers than most of the older varieties in the test conducted in 1943. Tennessee Greenpod was the most densely populated. Lima beans were less densely populated than were other shell or snap beans.

The thrips population varied from none to 35 per 100 square inches of leaf surface. The relative susceptibility of the varieties was reversed as compared with the leafhopper populations. The Refugee-type beans were, in general, more heavily infested with thrips than other varieties. The Great Northern variety was as heavily infested as the Refugee strains. There was no difference in the degree of thrips infestation on lima beans.

Data were secured relative to bean weevil incidence in beans in storage. After the mature beans were harvested and bagged in the field, they were stored in a warm room until January, then threshed. At the time of threshing the degree of infestation of

bean varieties, other than limas, varied from 0 to 50 per cent. Only two out of 16 samples of lima beans became infested and these to the extent of only one bean in a total of 400 examined.

Harry L. Gui

ONIONS

Thrips-resisting Onion Varieties

The possibility of developing a commercial type of onion with a high degree of resistance to the onion thrips appears promising.[6] Thrips-resisting lines have been developed, and these are now being crossed with standard varieties in an attempt to incorporate into desirable commercial sorts those factors which restrict the thrips population.

During the past year the program included detailed observations and study of inbred lines and progenies of crosses between commercial varieties and thrips-resisting lines. For the most part, progenies with nonglossy foliage were discarded, since in earlier investigations it has been found that glossy foliage is associated with thrips resistance. Bulbs grown from glabrous plants with a high sheath, a wide angle between leaves, and round, tough leaves were selected for further selfing and crossing.

A number of lines with pure glossy foliage have been developed which are approaching the commercial type. It appears likely that within a few years new thrips-resisting varieties will replace many of the sorts now grown in Ohio.

J. P. Sleesman

POTATOES

New Late Potato is Named "Erie"[7]

The Ohio Experiment Station has been cooperating in a national potato breeding program and has tested hundreds of new seedlings developed by the potato breeders of the U. S. Department of Agriculture. As a result, several new varieties, such as Chippewa, Katahdin, and Sebago, are already widely grown in Ohio. The latest addition to this list has been named "Erie." It is an attractive, round, late variety that in the 8 year's test has yielded

[6]This project is carried on in cooperation with the Bureau of Plant Industry of the U. S. Department of Agriculture.

[7](Note: This project is conducted in cooperation with Entomology, as well as with U. S. Department of Agriculture.)

20 bushels per acre more than any other market type of late potato. Moreover, it is excellent keeper in an ordinary farm type of storage (Fig. 31).

Fig. 31.—The new Erie potato stored in a barn basement; photographed May 1.

John Bushnell

Search for a Leafhopper-resistant Potato

During the past year the search for a leafhopper-resistant potato included detailed observations and study of new and old varieties, new seedlings, and unselected progenies.[8]

The data show that there were highly significant differences in nymphal populations and in the amount of hopperburn between the named varieties studied. Sequoia showed the most resistance to leafhopper attack and the highest yielding ability of any variety tested. It was followed closely in resistance, but not in yield, by Ackersegen. Potomac, Mohawk, Green Mountain, Menominee, and Norkota showed more hopperburn than Sequoia but much less than Bliss Triumph, Pontiac, Irish Cobbler, Warba, and Earlaine. At first sight, it might appear that the early varieties are susceptible and the late varieties resistant but a number of late sorts such as Pontiac, Sebago, and Katahdin are rather severely injured.

Five thousand new seedlings, representing the progenies of 30 crosses between various sorts, were produced in the greenhouse at Beltsville, Maryland. These seedlings were grown in the field at

[8]This project is carried on in cooperation with the Department of Horticulture of the Ohio Agricultural Experiment Station and the Bureau of Plant Industry of the U. S. Department of Agriculture.

McGuffey, Ohio, and the amount of hopperburn was noted for each. The progenies which showed most resistance to leafhopper injury were crosses involving Sequoia, Katahdin, President, 336-18, and 336-144. From these, approximately 100 seedlings were selected for further trial on the basis of yield, tuber quality, and the ability to resist the leafhopper or to withstand infestation without suffering appreciable hopperburn injury.

J. P. Sleesman and John Bushnell

New Materials for Spraying Potatoes

The long-time potato spray program has included studies to determine the effectiveness of Fermate (ferric dimethyl dithiocarbamate), Dithane (disodium ethylene bisdithiocarbamate), Methasan (zinc dimethyl dithiocarbamate), Puratized N5-D (a quaternary ammonium compound), various fixed-copper compounds, and Bordeaux mixture in insect and disease control on Irish Cobbler potatoes.

Plots that received Fermate yielded significantly less than those that received Bordeaux mixture or copper-oxychloride-sulfate. Significantly better results were obtained when this material was applied as a dust than as a spray. Apparently, the outstanding weakness of Fermate is its inability to control the potato leafhopper, since it does give fair control of early blight.

The performance of Dithane when applied to potato foliage has been somewhat variable in Ohio. In some of the tests it has shown considerable promise but in others the results have not been so good. The addition of a mixture of zinc sulfate and lime to Dithane did not result in a significant increase in yield.

Plots sprayed with Methasan, in combination with calcium arsenate, gave larger yields than were obtained from those that received Bordeaux mixture. Methasan plus calcium arsenate gave good control of the potato leafhopper, of early blight, and better than average control of the potato flea beetle. On the basis of one year's work, this zinc-containing dithiocarbamate seems to offer considerable promise as a potato treatment.

Puratized N5-D, in combination with calcium arsenate, gave poor leafhopper control, poor flea beetle control, and low yields.

An 8-8-100 Bordeaux formula gave better insect control and larger yields than were obtained with a Bordeaux formula in which the lime content was reduced to one-half that of the copper sulfate.

Copper-lime and fixed-copper dusts carefully applied under optimum conditions and in sufficient quantity (80 pounds per acre)

to cover all foliage completely and at sufficiently close intervals to maintain this complete coverage gave results comparable to those secured by spraying with Bordeaux mixture.

The fixed coppers as a group were not as effective as Bordeaux mixture in the control of foliage insects and diseases, due, in a large part, to poorer adhesion during rainy periods. For this reason they have not replaced Bordeaux mixture and copper-lime dust to any extent as a potato treatment in Ohio. The chlorides were more effective than the oxides or the basic sulfates of copper.

Sulfur applied both as a spray and as a dust gave excellent control of the leafhopper, but the yields were significantly lower than those obtained with Bordeaux mixture. The addition of sulfur to Bordeaux mixture and to copper-lime dust was of no benefit. A lowering of the degree of foliage protection when sulfur was included in the formulas indicated a harmful effect by this material.

The addition of several load-building agents to Bordeaux and to fixed-copper formulas did not result in an increase in yield. Little benefit was obtained from combining pyrethrum or derris with a fixed-copper spray.

J. P. Sleesman and J. D. Wilson

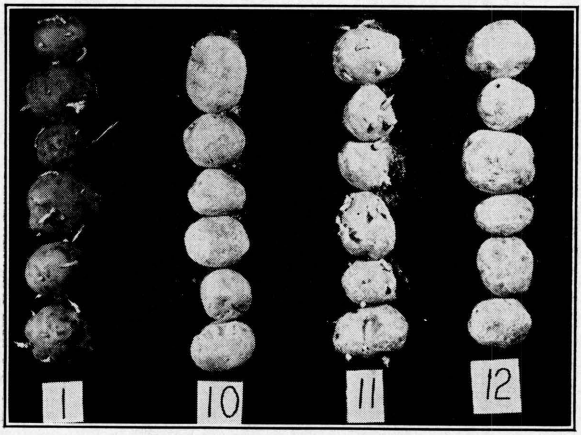


Fig. 32.—Effect of certain growth-retarding chemicals used in dusts and applied on tubers. (Variety, Irish Cobbler)

1. **Check tubers—no treatment**
10. **3 per cent methyl indolebutyric in Eastern Magnesium Talc 23**
11. **2 per cent 2, 4 dichlorophenoxyacetic acid in Eastern Magnesium Talc 23**
12. **3 per cent methyl naphthaleneacetic in Eastern Magnesium Talc 23**

Storage period, December 1, 1944—February 20, 1945. 65°-75° F.

Hormone Tests with Potatoes

Freshly cut tubers.—Naphthaleneacetic, indolebutyric, naphthoxyacetic, and 2, 4 dichlorophenoxyacetic acids in prepared dusts and Rootone, Transplantone, Hormex (gold and silver label), and Graino were used to treat freshly cut seed pieces of Katahdin and Chippewa potatoes before planting. They did not significantly increase the yield over that obtained from untreated plots. Further tests are planned with the most promising chemicals.

Potatoes in storage.—Various concentrations (0.05 per cent to 6.0 per cent) of the sodium salts and esters of naphthaleneacetic, naphthoxyacetic, indolebutyric, indoleacetic, and 2, 4 dichlorophenoxyacetic acids were used to attempt to inhibit sprout development of stored potatoes both at room temperature and in cold storage. It was found that the methyl esters of naphthaleneacetic, indolebutyric, and 2, 4 dichlorophenoxyacetic acids mixed in a talc carrier at 3.0 per cent, 4.0 per cent, and 5.0 per cent inhibited the development of sprouts from Irish Cobbler and Katahdin tubers which were stored at about 65-75° F. (Figure 32, p. 116).

H. D. Brown and Kenneth Alban

Barley Cover Crop for Potatoes

The plowing under of special crops in short rotations for early potatoes at the HAMILTON COUNTY EXPERIMENT FARM in general has not been as satisfactory as growing a hay crop and having a good legume sod to precede the potato crop. One reason for this is the difficulty of getting the land spring plowed under certain conditions. The soil is too heavy for ideal potato requirements and if it is plowed in the fall it is likely to become too compact before the potato crop is mature. Spring plowing, on the other hand, often faces the handicap that the soil dries out slowly under a heavy mat of vegetation, such as may be formed from a luxuriant fall growth of winter barley. As a result, planting may be delayed beyond the date when calendar and weather conditions indicate that the proper time has arrived.

M. A. Bachtell and C. W. Fryman

Sunflowers and Potatoes

Truck drivers between Cleveland and Pittsburgh have become used to referring to the MAHONING COUNTY EXPERIMENT FARM as "the place where they have those yellow flowers". These

are sunflowers which are grown in alternate years with potatoes as a crop to furnish organic matter. They grow a little more readily than sowed corn and are ready to disk into the soil in time to sow rye in August. The rye makes a good fall root growth and furnishes a large amount of additional organic matter to plow down in preparation for potatoes the following year.

L. W. Sherman and M. A. Bachtell

TOMATOES

Disease Resistance in the Tomato: A Breeding Experiment

The work of developing commercial tomato varieties resistant to the Fusarium wilt disease has been continued. This work is divided into the development of three types of tomatoes: a pink type adaptable for glasshouse culture; a red type adaptable for the market garden; and a canning type. Work has been continued on the development of lines of tomatoes to be used as differentials for the determination of physiologic races of the Fusarium wilt organism. In addition, attempts to cross the wild species *Lycopersicon peruvianum* variety *humifusum* (a type with high disease resistance plus very high ascorbic-acid content) with varieties of the domestic species have been continued with some success. Last year by growing the developed embryos, resulting from hybridization under asceptic conditions, the F_1 seedling was secured.

From a large number of crosses and combinations of crosses between the suitable glasshouse variety Globe and resistant lines, 22 selections have been made from three families. These lines are in either the fourth or fifth generations of selfing. They appear to yield well and possess good quality and should be yield tested. Their disease reaction to race 1 (the common, widely distributed race) is shown in table 17.

TABLE 17.—The reaction of the three families to race 1 of the Fusarium wilt organism

Pedigree	No. selections combined	No. healthy	No. slight	No. severe	No. dead
Globe x M-8-* x Globe; 5th self	6	134	5	3	1
Globe x M-8-2* x Globe x Globe; 4th self	10	225	6	4	5
Globe x M-21-2* x Globe x Globe; 4th self	143	1	0	0	0

*Breeding lines developed from *Lycopersicon pimpinellifolium* Missouri accession 160.

Selections for market-garden varieties of a red type have been narrowed down to 20 from six crosses. Trials have been conducted in northern Ohio and will be continued.

Breeding work for canning types has been conducted at Wooster and Holgate, Ohio. Yield trials were conducted at Holgate with 35 selections. The yields of three of the best selections in comparison with three commercial varieties are shown in table 18.

TABLE 18.—Yields of the three best wilt-resistant selections in comparison with three commercial varieties

Progeny	Yield, in tons per acre
1462-19-2-M	9.5
(IB x M-21-3) x Rut-1-1-M	8.5
(BB x M-8-2)-1-2-M	8.2
Cobourg	8.3
Rutgers	7.1
Indiana Baltimore	7.1

The development of lines to serve as differentials for distinguishing between the two physiologic races of the wilt organism has progressed well. The reaction of two differential lines to the new Ohio race and the old common race is shown in table 19.

TABLE 19.—The disease reaction of two differential lines to the two races of the Fusarium wilt organisms

Pedigree	Old common race				New Ohio race			
	Healthy	Diseased	Severe	Slight	Healthy	Diseased	Severe	Slight
(BB x *L. pimpinellifolium*) x BB-7-3-2-1	16	0	0	0	0	1	10	5
(BB x *L. pimpinellifolium*) x BB-12	16	0	0	0	0	0	4	12

L. J. Alexander

The Comparative Susceptibility of Various Tomato Varieties to Anthracnose

Sixteen varieties of tomatoes, most of which are in common use for the canning trade, were tested for susceptibility to anthracnose fruit rot. The varieties were planted in a series of randomized plots and in double rows. One row was sprayed at 10-day intervals with Fermate; the other of the pair was left untreated. The soil under the plants was artificially contaminated with the anthracnose organism just before the plants "broke".

Of the varieties used, John Baer was least affected in unsprayed plots and Earliana showed the highest percentage of anthracnose. The percentages of fruit affected were 14.2, 16.4, 18.4, 18.9, 24.1, 24.1, 34.5, and 43.4 for John Baer, Cobourg, Baltimore, Rutgers, Stokesdale, Garden State, Victor, and Earliana, respectively. The average infection on unsprayed plants was 24.3 per cent, and it was reduced to 7.1 per cent by spraying. This represented an average reduction of 70 per cent, which corresponds closely to results obtained in numerous other tests. As a general rule, the varieties most susceptible to attack by anthracnose were most benefited by the application of Fermate.

J. D. Wilson

Anthracnose Fruit Rot of Tomato

In greenhouse studies, the average length of the infection period for attached fruits inoculated by contact with artificially infested soil was 6.5 days for ripe, 9 days for pink, and 10 days for green fruits. All fruits inoculated at the pink or the ripe stage developed typical anthracnose lesions; 40 per cent of the fruits inoculated while green developed the disease as they approached the ripe stage. The infection period was shortened somewhat when detached fruits were inoculated by the above method or by a spore suspension. Pink to ripe fruits in contact with artificially infested soil in temperature tanks had anthracnose lesions after 3 to 4 days at 28° to 32° C.; after 6 to 7 days at 16° C.; and very few lesions after 8 to 10 days at 12° C.

Overwintering studies have shown that the causal organism may survive on both fruit and plant refuse and in the top layer of infested field soil, as evidenced by lesions developed after 4 to 5 days on ripe fruits placed in contact with such material transferred to the greenhouse during May.

Field tests have shown soil contact to be an important factor in infection. In an experiment involving ground and trellised tomatoes, 45.7 per cent of the former were infected with anthracnose; whereas, the first cluster of trellised fruits had 6.9 per cent diseased and fruits above the first cluster had only 2.1 per cent of disease throughout the season.

The influence of detachment of the fruits on anthracnose was demonstrated in a field experiment in which one-half of the fruits from a series of plants at mature green to "breaker" stage were placed on soil near the plants. After 10 days (when the fruits

were ripe), 13.1 per cent of the attached fruits had one or more anthracnose lesions, while 33.2 per cent of the detached fruits had the disease.

Additional field work involving injury to the epidermis of fruits by several methods and by defoliation of the plants by hand or by the application of injurious spray materials indicated that these factors may be expected to increase the incidence of tomato anthracnose.

H. A. Runnels and J. D. Wilson

Increasing Yields of Tomatoes Grown for Canning

The soil and climate of northwestern Ohio are peculiarly favorable for growing tomatoes for processing. The average yield in recent years has been over 6 tons per acre, which is almost 2 tons above the national average. The acreage has been rapidly increasing (Fig. 33).

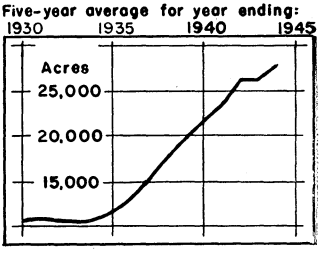


Fig. 33.—Acreage of tomatoes grown for processing in Ohio has nearly trebled in the past decade.

Experiments at the Northwest Test Farm, centrally located in this tomato district, have demonstrated methods by which yields may be raised to 10 tons per acre. The essential procedures are fall plowing, adequate fertilizer applications, ample space between plants, and the application of fungicides to control diseases.

John Bushnell

(See *also* Foods)

GLASSHOUSE CROPS

Glasshouse Vegetable Crops Production

An undescribed type of wilting of tomato plants, which is frequently followed by death of the plants, has been observed in glasshouses during the past 4 years. Its extent and occurrence are unquestionably increasing, although it has been observed only in northern Ohio. However, since the cause of the wilt is unknown, the possibility exists that this wilt may occur in other parts of the State. In general, yields have declined, even where the wilt has not been observed.

Because of the wilt and the declining yields, an extensive research program was initiated. This program is being conducted cooperatively by members of the Departments of Agronomy, Botany and Plant Pathology, Entomology, and Horticulture and is supported, in part, by a grant from the Ohio Hot-house Cooperative Association.

An extensive series of samples of glasshouse soils has been collected from all areas of the State. These samples are being analyzed to determine their chemical and physical properties. Experiments are being conducted at the Experiment Station at Wooster and in two commercial glasshouses in the Cleveland area. One of the commercial glasshouses was selected to represent the heavy clay soils; the other, to represent the light sandy soils of the State. The soil in the glasshouse at Wooster is an intermediate type. Several factors in the production of glasshouse tomatoes are being studied; particular emphasis is being placed on the determination of the amounts of organic and inorganic fertilizers needed, the required frequency of irrigation, and the amount of water needed per irrigation.

In the short time which has elapsed since the initiation of this investigation, the cause of the wilt has not been determined. However, several possible factors which were thought to be important have been eliminated. In addition, data are being accumulated which are yielding information concerning the proper applications of fertilizer and water.

F. S. Howlett, L. J. Alexander, J. B. Page, I. C. Hoffman, and R. B. Neiswander

Control of Soil-borne Diseases of Glasshouse Vegetable Crops by Nutrient-solution Culture

In previous years it has been possible to grow excellent spring crops of tomatoes, but fall crops failed from what appeared to be a root rot. It was found that the trouble was eliminated by the addition to the nutrient solution of one part per million of metallic copper as copper sulfate. This amount of copper, however, appeared to retard root development. One-half part per million of metallic copper gave excellent control without producing any visible effect on the plants. An excellent fall crop was produced in 1943, and a record of the absorption of potassium and nitrogen was obtained. Analyses were made on plant parts at the end of the season to determine the total absorption of nitrogen, potassium, calcium, magnesium, and phosphorus.

Considerable chlorosis having the symptoms of iron deficiency has been experienced in the spring crops during the months of May and June. Again, the nutrient solution was varied. This time, in order to keep more iron in solution, as much as five parts per million were added daily, with the result that chlorosis was reduced. To help the condition further, the phosphorus was reduced. This, in turn, further reduced the chlorosis but it appeared that the incidence of blossom-end rot increased.

Commercial grades of potassium and calcium nitrate, two salts seriously needed for commercial nutrient-solution production, have been unavailable because of the war. As a result, it has been necessary to substitute. Gypsum has been used as a source of calcium and it works well if it is of a high grade. Poor grades have too much foreign material, such as sand, to be satisfactory. Nitrate of soda has proven to be the most satisfactory source of nitrogen. Potassium sulphate as a source of potassium has given good results but is difficult to obtain.

L. J. Alexander

FUNGICIDES

New Fungicides on Vegetables

Copper-containing materials have been the principal source of vegetable fungicides since the discovery of Bordeaux mixture 50 or more years ago. During the past 5 years a series of new materials of organic composition have been coming into prominence in research channels for the control of specific diseases. Some of these "organics" now offer promise of usefulness in commercial vegetable growing. Fermate (ferric dimethyl dithiocarbamate) has given good control of tomato anthracnose and some of the foliage diseases of tomato and celery. A chemically similar material in the form of zinc dimethyl dithiocarbamate gave results comparable to Fermate on celery and tomatoes and, in addition, compared favorably with Bordeaux mixture on potatoes. Two organics known as Arasan and Spergon are coming into general use as seed-treating materials. Another dithiocarbamate known as Dithane has given variable results—some of them good—on tomatoes and potatoes. A quaternary ammonium compound under the name of Puratized gave good control of tomato anthracnose (a fruit rot) in 1944. These organic compounds, and probably many others, will be heard from further during the next few years.

J. D. Wilson

The Influence of Leaf Character on Adhesion of Copper Fungicides to Vegetable Leaves

The initial deposit of a fixed copper (COC-S) on 10 vegetables was regulated to a considerable extent by the character of the leaf surface (smooth or rough). The maximum range for the initial copper deposit was from 0.67 mg/dm^2 for Brussels sprouts to 3.74 mg. for eggplant. The average for the five smoothest-leaved species was 1.23 mg/dm^2 and 2.72 mg. for the five with roughest leaves. The corresponding amounts retained after 10 days of weathering were 0.25 and 0.63 mg/dm^2, respectively. The data for the same copper applied in a dust mixture were similar, except that the quantities for initial and final retention were smaller. More copper was deposited on smooth leaves as a dust than as a spray, but final retention was less. Twenty-one per cent of the sprayed material remained after weathering, but the retention was only 7.0 per cent for that applied as a dust.

These data are of considerable significance since they indicate that foliage diseases on smooth-leaved vegetables (celery) must be controlled with only about half as much copper as is available on rougher-leaved types (potatoes) when the fungicide is applied at the same rate per acre. Also, dusted plants retain only about half as much copper after a period of weathering as do those that are sprayed.

J. D. Wilson

GENERAL

Scarcity of Vegetable Shipping Containers

(See FRUITS, page 109)

(See *also* Foods)

Foods

STUDIES ON OHIO BUTTER

Vitamin A Potency

As part of a national survey made to determine the vitamin A potency of butter as produced and again after storage, samples of butter were collected, first at bimonthly and later at monthly intervals, from 12 Ohio dairies representing four geographical areas of the State.

As soon as the butter was received (in one-pound prints wrapped in parchment within a carton), a small sample was removed for carotene and vitamin A determinations and the remainder was stored at 0° F. At the end of 6 months and of 12 months, samples were removed from the remainder of the original print and again analyzed for carotene and vitamin A.

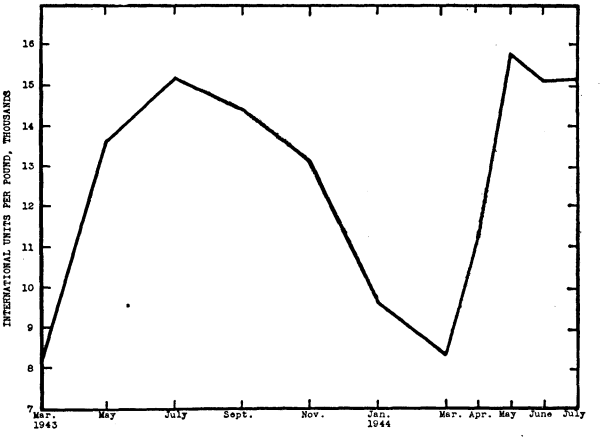


Fig. 34.—Vitamin A potency of Ohio butter

The method of the Technical Committee on Butter Analysis was followed throughout, using an Evelyn photoelectric colorimeter. Conversion of the carotene and vitamin A values to international units per pound of butter was made by applying the formula I. U. = (micrograms of carotene per gram ÷ 0.6 + Micrograms of vitamin A per gram × 4.0) × 454.

The vitamin A potency varied considerably with the season, from a low of 8,160 International Units, in March 1943, to a high of 15,700 International Units, in May 1944. There was little difference in the average potency of butter produced in the various geographical areas. Very little loss of vitamin A activity occurred after storage for 6 or 12 months. The slight loss that did occur was due to lowering of the carotene rather than the vitamin A and seemed to be confined to samples produced in the winter months. Average vitamin A values are shown graphically in figure 34.

Quality

The samples of butter used in the vitamin A study were scored when received and again after 6 months and 12 months in storage. The average score of the fresh samples was 89.7. This was reduced to 88.7 after 6 months in storage and to 88.1 after 12 months in storage.

Sixty per cent of the samples were criticized for oxidized flavors at the end of 12 months in storage. The oxidized flavors were termed oxidized, tallowy, or fishy.

There seemed to be no correlation between oxidized flavor and chemical composition (fat, salt, curd, and ash), mold mycelia count, or season of the year in which the butter was made.

W. E. Krauss, Louise Skinner, J. W. Hibbs, R. B. Stoltz, and W. L. Slatter

IRRADIATION PROCEDURE AFFECTS VITAMIN CONTENT OF EVAPORATED MILK

Samples of unirradiated evaporated milk and evaporated milk from the same source irradiated by various procedures so as to contain 135 and 400 U. S. P. units of vitamin D per reconstituted quart were assayed for carotene, vitamin A, ascorbic acid, riboflavin, thiamin, niacin, pyridoxine, pantothenic acid, and biotin. Chemical, biological, and microbiological procedures were employed in accordance with the suitability of these procedures for the particular determinations.

Carotene, thiamine, niacin, pantothenic acid, and biotin were not affected by irradiation to either the 135 or 400 unit level, but there were measurable losses of vitamin A, riboflavin, and ascorbic acid. In one trial, appreciable loss of pyridoxine occurred; in another trial, no loss was indicated. The average losses resulting from the irradiation procedure are indicated in table 20.

TABLE 20.—Vitamin losses occurring in evaporated milk during the irradiation procedure

	Irradiated to contain, per reconstituted quart:	
	135 U.S.P.U.	400 U.S.P.U.
	Per cent loss	*Per cent loss*
Vitamin A	4.0	15.4
Ascorbic acid	15.1	16.0
Riboflavin		
Microbiological	4.9	7.2
Colorimetric	2.6	9.5

W. E. Krauss, Louise Skinner, J. W. Hibbs, C. H. Hunt, and Lorraine Ditzler

THERAPEUTIC VALUE OF MILK FROM THYROIDECTOMIZED GOATS

Complete removal of the thyroid gland causes milk secretion to decline and ultimately to cease, but the milk that is produced may have therapeutic value. This was shown by studying the basal metabolic rate of rats fed either normal goat's milk or milk from goats that had been thyroidectomized. The basal metabolic rate of the rats receiving milk from the thyroidectomized animals was lower than that of rats receiving normal milk. This was emphasized in another experiment in which the basal metabolic rate was artificially stimulated by injecting thyroxine. Elevation of the basal metabolic rate was significantly less in the rats receiving milk from thyroidectomized goats.

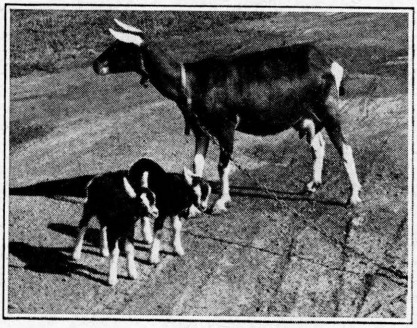


Fig. 35.—This doe produced the kids shown after her thyroid gland had been completely removed. Reproductive function was restored by feeding iodinated casein.

These results stimulate speculation as to the possible value of thyroprive milk in the treatment of exophthalmic goiter in humans.

A thyroidectomized goat can be restored to normal reproduction and lactation by feeding iodinated casein which is potent in the thyroid hormone. In figure 35 are shown a thyroidectomized goat and the twin kids she produced after being restored to normal reproduction by this method.

J. W. Hibbs, W. E. Krauss, and T. S. Sutton

MINERAL CONTENT OF TOMATO FRUITS

The effect was determined of different soil types, different levels of soil fertility, and different amounts of soil moisture on the amount of certain minerals in tomato fruits. There was a large number of analyses made.[9]

The standard fertilizer treatment consisted of 50 tons of manure, 1,000 pounds of 20 per cent superphosphate, 750 pounds of 50 per cent muriate of potash per acre, and six applications of nitrate of soda applied at the rate of 250 pounds per acre. All of the supplements were applied at the beginning of the crop except the nitrate applications. The nitrate applications were applied at intervals of 10 days as side dressings and then watered in. A series of plots was set up varying the amount of chemical fertilizers one-half, three-fourths, one, one and one-half, two, three, and four times the standard treatment. The same amount of manure was used on all of the plots and was applied once a year preceding the fall crop.

Analyses were made particularly for total nitrogen, calcium, magnesium, phosphorus, and potassium, although the percentage of dry matter, moisture, and ash were also determined. In general, the minerals increased as the fertilizers were increased, but the differences were not large. Total ash increased also with the increase in the amount of fertilizers. Moisture increased up to the middle of the range of treatments and then decreased fairly rapidly.

In another bed, where a similar rate of fertilization was maintained but the soil was adjusted to alkaline, neutral, and acid conditions in duplicate plots, the nitrogen was applied as nitrate and ammonium in these plots, respectively. Differences were relatively small. More nitrogen was taken up from the nitrate in the alkaline soil, while more was taken up from the ammonium in neutral and acid soils. The minerals calcium, magnesium, phosphorus, and potassium were absorbed in somewhat greater quantities where ammonium was applied, with the exception of magnesium and potassium in the acid soil. In these two cases more of them were absorbed in the fruits though the differences were not large.

In other plots where tomato plants were deficient in nitrogen, potassium, and phosphorus, respectively, these minerals were present in the fruits in much lower amounts than in those receiving complete fertilizers in adequate amounts.

I. C. Hoffman

[9]The chemical methods were worked out with the help of the cooperator, I. W. Wander, and were adopted last year (1943).

CONSERVATION OF VITAMIN C AND CALCIUM VALUES OF SOME OHIO FOODS

This study was undertaken in connection with the national cooperative project, "Conservation of Nutritive Value of Foods." It was thought that information concerning the nutritive value of some Ohio foods might help in evaluating the contribution that these foods make to the vitamin C and calcium content of diets.

Tomatoes.—Although tomatoes are considered a good source of vitamin C, information is limited as to the relative amounts of this vitamin in tomatoes after storage, cooking, and canning. Using freshly harvested tomatoes as a reference value, a study was made to determine the effect on vitamin C of the following factors: (1) holding raw tomatoes at room and at refrigerator temperatures for varying periods of time; (2) cooking; (3) holding cooked tomatoes for varying periods of time in a double boiler; (4) holding the cooked product in the refrigerator for 24 hours and then reheating; (5) canning; and (6) holding the canned tomatoes in dark storage for varying periods. The tomatoes used in these tests were produced by the Department of Horticulture, The Ohio State University.

The results of the study indicate that there was a slight reduction in vitamin C during the storage of raw tomatoes and that the loss is slightly less when tomatoes are stored in a refrigerator than when they are stored at room temperature.

The loss due to preparation for cooking (removal of skin and core) and cooking amounted to 18 per cent of the reference value. This loss was increased to 45 per cent when the tomatoes were held in a double boiler for 3 hours. Storing the cooked tomatoes in the refrigerator for 24 hours and then reheating was less destructive of vitamin C than holding them in the double boiler for 3 hours.

Tomatoes canned in glass by the hot-pack method showed a loss of 16 per cent due to the canning process. During storage of the canned tomatoes, the greatest loss occurred during the first 45 days. There was no apparent loss during the period from 45 to 90 days, but from 90 to 180 days there was a loss almost as great as that of the first 45 days. Tomatoes canned during the previous year and stored for 12 months showed a reduction in vitamin C during the storage period from the sixth to the twelfth month.

The results would seem to indicate that freshly harvested tomatoes contribute appreciably more vitamin C to the diet than do either cooked or canned tomatoes and that canned tomatoes stored for from 6 to 12 months may contain only about 60 per cent as much vitamin C as they did soon after being canned.

Collards.—Although this vegetable is not so commonly used in Ohio as some other green leafy vegetables, it was included in this study because of its high content of calcium and vitamin C. The collards for this study were grown by the Department of Horticulture of The Ohio State University.

Freshly harvested samples were frozen and stored in the freezer locker and then tested at the end of the following periods: 24 hours, 6, 9, and 12 months. These tests showed that there was a progressive decrease in the amount of ascorbic acid retained. As compared with the amount of ascorbic acid in the frozen vegetable after being stored in the freezer locker 24 hours, the percentage retentions at the end of 6, 9, and 12 months storage periods were 85, 70, and 62, respectively.

Portions of these samples were cooked and tested at the end of each storage period. In all cases, a larger percentage of ascorbic acid was found in the cooking water than in the cooked drained vegetable. The proportion between the amount of ascorbic acid in the cooked drained vegetable and in the cooking water remained approximately the same, regardless of the length of time the vegetable had been stored in the freezer locker. Losses due to the cooking process were greatest for those collards that had been stored for 12 months in the freezer locker.

The calcium content of collard leaves averaged 469 milligrams per 100 grams as compared with 178 milligrams per 100 grams for collard stems.

Cabbage.—Samples of five varieties of summer cabbage were studied to show the effect of the following factors on the ascorbic acid values: variety, storage, and some of the commonly used home practices. Details of this work will be found in Department of Home Economics mimeographed publications 2 and 3 of this station.

Strawberries.—Samples of the Premier variety were tested on the day of harvesting and were found to be rich in vitamin C. Tests made on samples held in a refrigerator for 24 hours indicate that strawberries retain their vitamin C values well during storage in a household refrigerator.

Some samples were frozen on the day of harvesting and held in the freezer locker for 24 hours, 6, 9, and 12 months. There was no apparent loss of vitamin C during the first 24 hours, but there was a progressive decrease in the amount retained during the longer periods of storage. For the 6-, 9-, and 12-month periods the percentage retentions were 42, 30, and 21, respectively, of the amount in the freshly harvested berries.

Hughina McKay and Mary Brown Patton

FERTILITY LEVELS AND CAROTENE CONTENT OF VEGETABLES

Cabbage, cauliflower, lettuce, and sprouting broccoli were grown in water-culture plots in the greenhouse and in the permanent fertility plots outdoors. Yellowed foliage, caused by lack of fertilizing materials, always contained less carotene than did dark green foliage. No significant differences could be detected between the carotene contents of those vegetables receiving adequate amounts of fertilizing elements when compared with those receiving more than adequate amounts of the various elements. Limiting the supplies of nitrogen, magnesium, potassium, and iron was especially effective in producing light-colored foliage low in carotene.

H. D. Brown and M. R. Shetlar

QUALITY OF FROZEN VEGETABLES

There were 49 varieties of vegetables selected for freezing from the Division of Plant Industry variety tests at Columbus. These included varieties of green and wax beans, lima beans, peas, corn, carrots, and beets. Six packages of each variety were processed and frozen according to the best known methods; the packages were then stored for a period of 4 to 6 months before they were removed from the freezer and tested for quality by five judges. Upon the results of these tests, the following varieties of vegetables are recommended:

Peas—Thomas Laxton and Laxtonian
Green beans—Giant Stringless Green Pod, Bountiful
Wax beans—Pencil Pod Black Wax
Lima beans—Henderson Bush, Fordhook Bush
Yellow corn—Golden Cross Bantam, Golden Bantam
White corn—Country Gentlemen, Stowell's Evergreen
Carrots—Chantenay, Nantes
Beets—Ohio Canner, Edmond's Blood Turnip, Detroit Dark Red.

H. D. Brown

(See *also* Fruits and Vegetables)

Special Crops

SUGAR BEETS

Segmented Sugar Beet Seed

A few years ago it was discovered that the beet seed ball could be broken up into segments containing primarily one germ. It was thought that by planting such segments in a uniform spacing that much of the hand labor normally necessary for blocking and thinning could be eliminated. The first obstacle encountered in the use of segmented seeds was in the drilling. To determine suitable methods, a series of tests was set up in 1943 in which the Superior and John Deere drills were used. The segmented seed was scarified and sized at 7/64 to 9/64. The drilling tests were located near Amsden and on the Ralph Watson farm at Old Fort.

The results obtained were distinctly unsatisfactory. The stands were not even. There were too many skips, due to bunching and lack of uniform germination, to permit mechanical blocking.

In a check series where whole seed was sown, cross blocking with a special type cultivator and the Dixie thinner was possible. However, the plots had to be gone over by hand and thinned.

H. C. Young

Sugar Beet Seedling Diseases

The fungus, *Aphanomyces cochlioides*, is primarily responsible for the loss of sugar beet seedlings in Ohio. Disease caused by *Rhizoctonia* sp. is less common but sometimes very severe. Seedling loss due to *Phoma betae* and *Fusarium* sp. occurs only to a minor degree.

The use of high phosphate fertilizers in the row at planting time usually has reduced seedling diseases in the field on soils which have had a liberal application of manure. In greenhouse experiments, row applications of either 20 per cent superphosphate

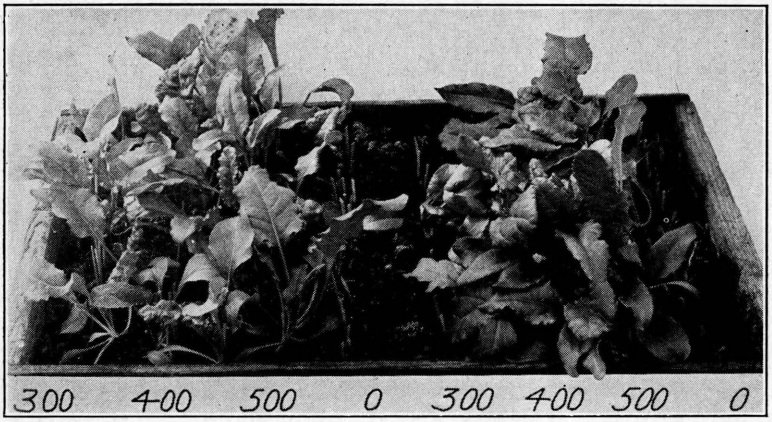


Fig. 36.—Soil containing manure was inoculated with *Aphanomyces cochlioides*. Figures indicate number of pounds of 20 per cent superphosphate per acre placed in the row with the seed. Toothpicks, which can be seen in rows where 0 and 300 pounds of superphosphate were used, indicate plants that became diseased and died.

or complete fertilizer has reduced the Aphanomyces disease but has had little or no effect on diseases caused by the other organisms. (Figure 36).

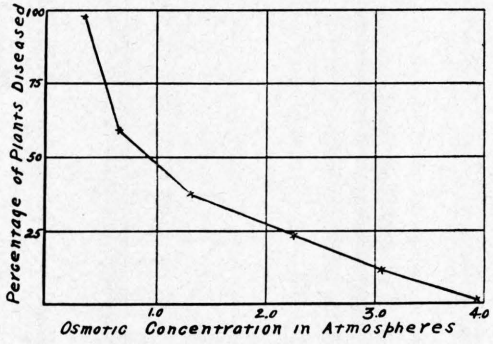


Fig. 37.—Average percentage of diseased sugar-beet seedlings which developed in gravel cultures inoculated with *Aphanomyces cochlioides* and irrigated with nutrient solutions of different concentrations.

When beet seedlings were grown in gravel, inoculated with Aphanomyces, and irrigated with a modified Hoagland solution, seedling dying decreased as the solution concentration was increased from 0.3 atmosphere to 3.78 atmospheres. (Figure 37).

The phosphate content of the nutrient solutions was held constant and the increase in concentration was obtained by increasing the other chemicals. It would seem, therefore, that the protective effect of the high concentration solutions is due to something other than the phosphate ion concentration.

Increasing the phosphate content of culture media from 190 to 9000 p. p. m. had no retarding effect on growth of *A. cochlioides*. Also, when the fungus was grown in Hoagland's solution prepared with soybean extract at concentrations ranging from 0.8 to 2.8 atmospheres, it was found that the higher concentrations did not retard growth. Since increasing the concentration of nutrient solutions did not retard growth of the parasite but did reduce the incidence of disease, it is evident that the seedlings grown in the high concentration solutions were more resistant to attack by the Aphanomyces organism.

Experiments have shown that seed treatments are effective against Rhizoctonia but that they have little or no value for controlling the disease caused by Aphanomyces.

Paul E. Tilford and H. C. Young

TOBACCO

Tobacco and Cover Crops

Tobacco grown continuously on the same land at the SOUTHWESTERN EXPERIMENT FARM has yielded well when a barley cover crop has been sown after each tobacco harvest and the tobacco fertilized in the row each year with 600 pounds of 2-12-6 per acre. In general, the yields have compared favorably to those obtained where the tobacco is grown in rotation. The use of 200 pounds of sulfate of ammonia per acre when plowing down the cover crop also has been justified. Tobacco responds to more than 600 pounds of fertilizer in the row and more can be used with profit if the planter has the mechanics for properly applying it.

H. L. Wachter and M. A. Bachtell

BELLADONNA

Production of the Drug Belladonna

Germination.—To secure high germination, immerse seeds for 60 to 100 seconds in commercial sulphuric acid, soak in water for 23 hours, and sow in sandy medium. Maintain a temperature of 90 degrees F. for one week and then reduce the temperature to 60 degrees F.

Nutrition.—High nitrogen levels increase production. Low levels of phosphorus and potassium are satisfactory. A pH of 5.5 to 5.6 is most satisfactory.

Time of fertilizer application.—To secure higher assays, nitrates should be applied in the vegetative stage.

Colchicine.—Treatments with this chemical proved ineffective.

Hardening.—Treatment prior to planting is conducive to quicker establishment in the field and to higher yields.

Assays.—The highest assays are secured when harvesting takes place during the flowering period.

Alkaloids.—Alkaloids are greater in immature foliage.

Alkaloid relocation.—When mature plants are cured whole, regardless of upright or inverted position, the quantity of alkaloids in the roots is diminished and the quantity in the foliage is increased. If the roots are removed, the alkaloid ordinarily present in the stems is shifted to the leaves.

Mulching.—In light soils a heavy mulch is conducive to overwinter survival. In heavy soils a medium mulch is indicated. Winter survival may also be increased by reduction of the soil-nitrogen level to 10-50 p. p. m. toward the end of the growing season.

Alex Laurie

Forestry

Also Report of Division of Forestry

PRODUCING WOOD FOR WAR AND POST-WAR YEARS

The full impact of the war on the forests in Ohio is still cushioned to a marked degree by the scarcity of labor and, to a lesser degree, by the difficulty in obtaining supplies required in logging and milling and equipment for transporting logs and lumber.

Many large logs have gone to market at fancy prices; whereas small timber, which is still being overcut, brings much lower returns to the owner and higher operating expenses to the buyer. The same wide margin of profit which tempts the logger to the premature slaughter of small trees also makes it possible for the alert owner to insist on the removal of culls and trees of poor form.

The strong market for large timbers and the natural desire on the part of many timber owners to make a contribution to the war effort have resulted in the cutting of many tracts of mature timber. Quite frequently, because these woods were landmarks in the community, their removal gives rise to a loss-of-woods consciousness which was much less prevalent prior to Pearl Harbor.

This feeling that we are on our way to a prairie state takes on added significance when wells and springs go dry, farmers haul water for stock, and cities wonder about the supply of water for domestic and industrial purposes.

Although the relationship between forest cover and available ground water supply may occasionally receive undue emphasis, there is no denying the fact that many thinking people are water conscious and hence are quite willing to sponsor measures which give promise of improving the water supply. Of these measures, and there are several, the maintenance in forest of lands not suitable for other purposes is one of more than minor importance.

This increased interest in forests is reflected in the more active demand for planting stock, not only from people who have been planting trees over a number of years but also in orders and inquiries from new cooperators, among whom industry is well represented.

Motives for planting trees do not appear to spring from a common source. One company may desire specialty products such as black walnut and white ash, while others may want fence posts, mine props, or just a crop growing on otherwise idle land. One large company has prepared detailed plans for reforesting the larger part of a 20,000-acre holding as soon as labor can be obtained. A private land owner has plans for planting 2,000,000 trees, and he is well along towards the half way mark to his goal. Many others contemplate more modest programs.

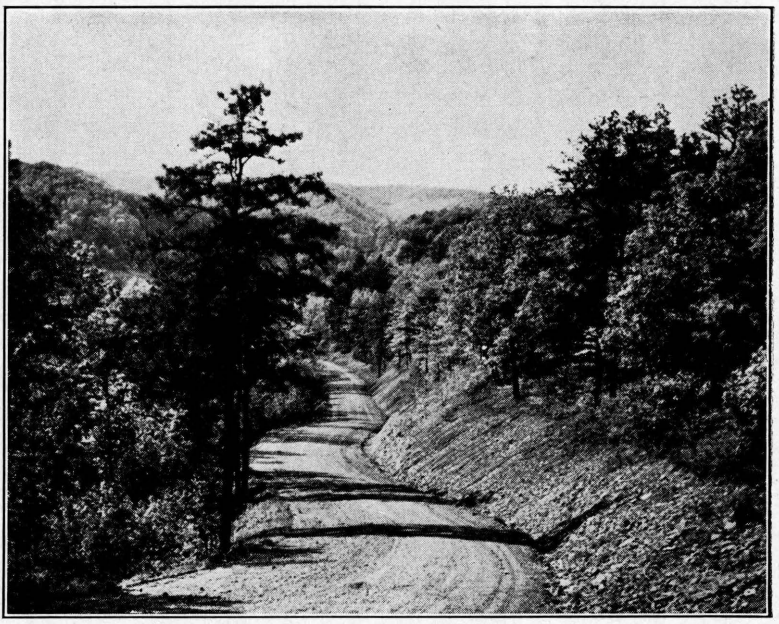


Fig. 38.—Winding woods roads offer a strong appeal to the nature lover. These roads are an important factor in forest fire control.

As the interest in forestry grows, the expansion of the state forests and forest parks is again proposed as the only movement which, at this time, offers a workable means of reforesting many extensive areas of idle and abandoned land.

In this movement there is seen also a substantial contribution to the growing needs for outdoor recreational facilities. A recent study reveals that 21 state forest and forest park purchase areas could be established, within which could be purchased nearly 600,000 acres of land that is not likely to be reforested with private capital. Within these areas are numerous spots which are scenic

and would be worthy of development for recreational purposes. The value of such facilities within reach of large centers of population is difficult to appraise in dollars, since it is manifest only in a more contented populace.

As might be expected, a greater appreciation of forests brings support for their protection. In 1944, for the first time, has there been anything like adequate forest fire control, and one should hasten to add that many improvements are possible in this field when labor conditions return to normal. While a scarcity of labor has made suppression of fires a critical problem, the number of people with time to spend in the woods has been so greatly reduced that fire occurrence has decreased in approximately direct proportion. This tends to hold the area burned at about a normal figure.

Many favorable reports come from the region wherein airplane patrol has been used to detect fires. Pilots can determine at once whether the fires are under control, and, if help is needed, they can quickly drop a message to the nearest warden who may not have a telephone. Wardens thus know in advance the location and size of the fire, as well as the type of property threatened. Quick action has saved many farm buildings, stacks of hay, mining and oil-well structures, as well as timber resources. Records of the number of fires investigated are being kept and compared with the fires observed from lookout towers. After the war when towers are again on the market, the results of this study will determine the future use of planes as a substitute for tower observation.

Post-war Recommendations

At the risk of being premature, some recommendations are set forth below which may be of value in the period following the war, when and after the country returns to a peace-time economy.

It is likely that timber production during post-war years will exceed the output during the war. Because of this, it would be desirable to enlarge the staff of foresters available to assist timber owners in the management of their woods. This is proposed as an alternative to federal or state forest regulation which continued forest abuse will bring about.

The state forests and forest-park units should be purchased at an early date, in order that the State may benefit from public-works' programs similar to the Civilian Conservation Corps.

The state tree nurseries should be enlarged to meet post-war demands.

Adequate forest-fire control should be maintained.

Forest research should furnish practical answers to questions which post-war forestry will raise. The present research facilities will not meet this need unless expanded.

Education and public relations work should be directed toward the schools and be designed to serve both student and teacher.

O. A. Alderman

STATE FOREST AND FOREST PARK OPERATIONS

Land Acquisition

The 95th General Assembly appropriated $20,000 for the purchase of state forest land during the 1943-44 biennium. However, payment of funds for acquisition was virtually suspended during 1944, as well as during the preceding year, because of the lack of favorable action on the part of the Fiscal Controlling Board. Two tracts were presented for Board approval. The acquisition of the one tract of 31.4 acres would have provided additional parking room for cars visiting Ash Cave and a much needed buffer strip to protect the park. The purchase of another tract of 240 acres would have given the State a double road frontage for ¾ mile on Route 374 between Ash Cave and Old Man's Cave.

In conformity with the provision of Section 1177-10a of the General Code, an attempt has been made to complete the preparation of a so-called Land Acquisition Atlas of Ohio State Forests and Forest Parks.

Maps were prepared for each purchase unit and bound in five atlases. On each of these maps the limits of the Purchase Unit were indicated by a broad red line. Within the limits so represented were drawn to scale the lands which are already under the jurisdiction, management, and control of the Division of Forestry.

A copy of this Land Acquisition Atlas which contained maps and descriptions of 15 purchase units was submitted for approval to the Board of Control of the Ohio Agricultural Experiment Station at its October 1944 meeting. The maps of these 15 units were accepted and approved by the Board at that time. Subsequently, at the December 1944 meeting of the Board, maps of six additional purchase units were presented and approved.

Table 21 provides in more detail the general facts and figures relating to the State Forest and Forest Park purchase units which were approved in 1944 by the Board of Control of the Agricultural Experiment Station.

During the year, considerable work and study were applied to the Hueston Woods area in Butler and Preble Counties, looking toward the enlargement of the 377-acre forest now controlled by the Division of Forestry. The plan calls for a state forest park of 4,800 acres to be carefully designed and completely developed as to recreational facilities.

TABLE 21.—Location and area of Ohio State Forest and Forest Park Purchase Units

Name of unit	County	Gross area	Net area to be purchased	Estimated cost	Area to be re-forested
		Acres	*Acres*	*Dollars*	*Acres*
Beaver Creek	Columbiana	18,000	7,800	234,000	3,120
Blue Rock	Muskingum	58,487	26,825	321,900	13,412
Brush Creek	Scioto, Adams, Pike	111,882	67,000	402,000	13,400
Bryan	Greene	2,121	500	25,000	200
Dean	Lawrence	1,800	.....	.....	.....
Findley	Lorain	4,096	1,600	32,000	960
Hocking	Hocking	78,400	43,532	653,000	13,060
Hueston	Preble, Butler	4,000	3,623	400,000	2,173
Little Mountain	Lake, Geauga	20,030	12,000	600,000	3,600
Mohican	Ashland, Holmes, Knox	25,200	10,000	200,000	5,000
Nelson Ledges	Portage	4,364	2,180	109,000	872
Oak Openings	Lucas, Henry, Fulton	25,600	15,360	460,800	9,216
Pike	Pike, Highland, Ross	93,870	65,800	526,400	13,160
Raccoon Creek	Gallia, Jackson, Vinton	85,457	48,180	385,440	12,045
Scioto Trail	Ross	23,516	8,660	86,600	1,732
Shade River	Meigs	72,800	36,400	364,000	18,200
Shawnee	Scioto, Adams	142,300	82,900	580,300	8,290
Sunfish Creek	Monroe	67,840	44,100	441,000	17,640
Tar Hollow	Hocking, Ross, Vinton	55,759	30,100	270,900	4,515
Yellow Creek	Columbiana, Jefferson	74,880	47,200	472,000	14,160
Zaleski	Athens, Hocking, Vinton	78,660	34,060	340,600	5,109
Total	.....	1,049,062	587,823	6,904,940	159,864

Timber sales.—Fourteen separate timber sales were carried over from 1943, and, in addition, two new areas were marked and offered for sale. One area was on the Pike Forest in the Left Fork of Morgan Fork drainage; the other, on the Shawnee Forest in Rarden Creek.

There was no bidder on the Pike Forest offering. The Rarden Creek area sold to Laten Hilterbran of Peebles, Ohio. The sale was for $15.00 per thousand board feet on poplar; $12.00 on oak, gum, and soft maple; and $10.00 on hickory. These prices apply to timber on the stump.

Gross sales were $40,416.15, as compared with $37,221.38 in 1943, $20,437.60 in 1942, and $7,818.24 in 1941. Gross footage removal consisted of 1,373,007 board feet, as contrasted with 1,508,789 board feet in 1943, 1,340,125 board feet in 1942, and 1,003,609 board feet in 1941. The average selling price per M board feet figures $29.43 in 1944, $24.66 in 1943, $15.25 in 1942, and $7.79 in 1941.

Fig. 39.—Harvesting black locust fence posts. Nearly 28,000 posts were sold in 1944.

Since 1939, 25 per cent of the net proceeds from timber sales has been returned to the counties in which the forests were located. The amount of these returns is shown in table 22.

TABLE 22.—Amounts refunded to counties from state forest timber sales

County	1939	1940	1941	1942	1943	1944	Total
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Portage	.....	1.23	.....	.....	.....	.....	1.23
Adams	12.73	108.84	73.61	28.49	264.84	418.81	907.32
Ashland	466.79	43.25	113.27	62.56	430.50	31.25	1,147.62
Athens	18.75	.....	6.23	146.22	758.05	544.65	1,473.90
Greene	.....	4.50	3.25	.....	5.25	.....	13.00
Highland	55.58	94.80	23.01	15.81	265.49	769.95	1,224.64
Hocking	96.86	104.58	60.20	128.28	279.42	270.56	939.90
Lawrence	.....	.....	52.44	2.66	.....	13.49	68.59
Lorain	7.50	8.00	2.00	5.91	2.52	2.83	28.76
Pike	360.37	365.28	638.59	551.43	395.16	415.97	2,726.80
Preble	.....	.....	.....	.....	.....	3.63	3.63
Ross	133.54	6.87	13.54	104.28	257.39	594.86	1,110.48
Scioto	.63	58.05	189.25	608.11	686.95	586.19	2.129.18
Vinton	19.16	2.19	50.99	274.82	497.25	463.72	1,308.13
Total	1,171.91	797.59	1,226.38	1,928.57	3,842.82	4,115.91	13,083.18

The hardwood market which boomed the 1943 market started to subside in early 1944. The first evidence of a slackening in demand came when the Columbus Depot ceased buying as many pallets, which were made of low-grade hardwood lumber. This

move was immediately felt by the sellers of tie siding and the lower grades of four by four. The next checking of the market was due to the application of WPB order L-335, a control of lumber marketing. The effect of this was to greatly enhance the demand for the upper grades. When a manufacturer was limited in the footage he could get, it behooved him to buy the grades which would cut out the most clear material. In southern Ohio, the end of the year finds a strong demand for No. 1 Common and Better, but some rather heavy stocks of No. 2 and 3 Common.

In view of the need for pulpwood, the Division of Forestry made a special effort to assist in this supply in 1944. A carload of pine was shipped from Scioto Trail Forest and one from Dean Forest. Both of these came from plantation thinnings. From Zaleski, 19.22 cords were furnished; from Scioto Trail, 1.65; and Tar Hollow made a notable record in getting out 75.35 cords.

Two cars of high-grade oak and beech were sold to the United States Treasury for lend-lease shipment.

TABLE 23.—Total gross income versus labor and materials, by forests—1944

Forest	Income	Expense	Gain	Loss
	Dol.	*Dol.*	*Dol.*	*Dol.*
Shawnee	5,643.66	11,676.20	.....	6,032.54
Tar Hollow	7,709.35	16,787.75	.....	9,078.40
Scioto Trail	6,918.90	10,251.85	.....	3,332.95
Pike	9,075.34	7,243.96	1,831.38	.....
Dean	334.27	875.80	.....	541.53
Zaleski	22,815.75	22,119.38	696.37	.....
Blue Rock	1,800.23	3,991.45	.....	2,191.22
Ash Cave	486.55	915.21	.....	428.66
Cantwell Cliffs	618.15	877.93	.....	269.78
Old Man's Cave	2,408.82	2,912.93	.....	504.11
Rock House	1,868.94	1,095.83	773.11	.....
Waterloo	5,904.60	3,524.53	2,380.07	.....
Mohican	1,625.00	125.86	1,499.14	.....
Findley	139.50	189.68	.....	50.18
Nelson Ledges	9.94	15.50	.....	5.56
Bryan	6,252.75	5,736.98	515.77	.....
Hueston	734.54	.....	734.54	.....
Total	74,346.29	88,350.84	8,430.38	22,434.93
Net loss	.....	.....	.....	14,004.55

Sales of both Christmas trees and greens dropped somewhat from 1943. This was partly due to a greater supply in 1944 of shipped-in trees, to the fact that many dealers lost in 1943 due to a glut in the late days of the market, and to the very bad weather conditions in the critical days just before December 25, 1944 which made harvesting and delivering most difficult.

Railroad ties, to the number of 5100 pieces, were either manufactured by contract sawmills or sold on the stump to be hewn.

Reforestation.—Most of the lands, when purchased for state forests, were fairly well covered by young, natural, forest growth, but many tracts contained cleared fields usually eroded and run down. In order to check this erosion and establish a forest cover as quickly as possible, artificial reforestation was resorted to, until at the present time over 6,600 acres of artificial plantations have been established within the state forests and forest parks.

It is quite noticeable that several of the state forests that contain well developed recreational and scenic areas also include within their boundaries hundreds of acres of successful plantations.

Two-thirds of all the forest plantations are situated within less than half of the state forests:

Tar Hollow	1,331.1 acres
Zaleski	1,300.0 acres
Mohican	763.0 acres
Blue Rock	521.5 acres
Hocking	488.7 acres
Total	4,404.3 acres

Plantations were thinned on the Shawnee, Tar Hollow, Scioto Trail, Pike, Zaleski, Blue Rock, and Hocking. These operations yielded 4,015 Christmas trees, which sold for $2,546.79, and 10,105 pounds of Christmas greens, yielding $403.10. In addition, considerable pulpwood and a little charcoal was manufactured from the rest of the thinnings. The policy of thinning red-pine plantations will be continued. New red-pine plantations should be spaced wider so that when they are thinned the products may be larger and more economically handled.

Growth study.—During the year, considerable work was done on the Shawnee Forest, where, in 1924, a base line was surveyed from north to south through the Forest for a distance of over 4 miles; from 10 chain stations on this line, sample strips were run to the boundary and within the strips the timber was measured by 40-acre blocks.

Twenty years later the 40-acre blocks on either side of the base line were measured again, and the results were compared with the original data. A great deal of valuable information will be obtained from this study which will be reported at a later date.

B. E. Leete

RECREATIONAL USE OF STATE FORESTS AND FOREST PARKS

The use of the state forests and forest parks for recreational purposes has not changed to any marked degree during the year. Driving restrictions and longer hours of employment tend to keep people at home or to limit the number of excursions to distant recreation spots. Record use of these public holdings may be effected after the war and plans are being made and proposed to meet this situation.

Picnicking.—As during the 2 previous war-time years, this type of recreation continued to be curtailed approximately 25 per cent of normal. This held true on all forests, except John Bryan State Forest Park; this park is near densely populated cities which are engaged in war work, such as Dayton, Springfield, and Xenia. The attendance in this park was again about 80 per cent of normal. The following figures show the attendance on Sundays and Holidays in four of the Hocking Parks. These figures include both picnickers and sight-seers.

Forest park	State visitors		Out of state visitors		Total	
	Cars	Visitors	Cars	Visitors	Cars	Visitors
	No.	*No.*	*No.*	*No.*	*No.*	*No.*
Old Man's Cave	2,170	9,272	89	329	2,259	9,601
Cedar Falls	407	1,690	6	18	413	1,708
Conkles Hollow	768	3,686	14	49	782	3,735
Ash Cave	1,868	7,546	67	272	1,935	7,818

On the Zaleski area, there were approximately 30,000 visitors, which is much less than in pre-war years but greater than in 1942 and 1943.

Fishing and hunting.—According to the reports of the rangers and the Game Management Division of the Conservation Department, the number of fishermen using the forest lakes was less than in 1943.

Hunting was less than in former years, although the controlled rabbit hunting on the Findley Forest and deer hunting on the Shawnee Forest were successful. The take of game was less than in the previous years.

Swimming.—Swimming receipts showed an increase over 1943, except at John Bryan where the decrease is attributed to racial controversies and to the fact that the V-12 Army Unit had been moved from the campus of Antioch College.

Swimmers at Orton Pool during the 1944 season numbered 24,783, including the Boy Scouts and 4-H campers who swam without charge. Income from the pool totalled $3,130.00; the operating costs, $1,914.75.

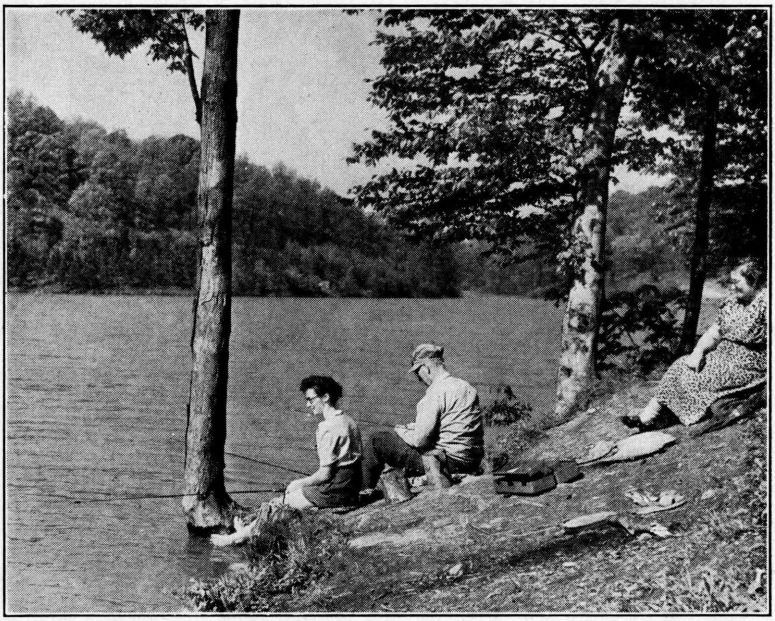


Fig. 40.—A restful hour on the shore of Lake Hope.

At Zaleski the number of swimmers exceeded the 1943 figure, nearly equaling the attendance in 1942. The swimming season lasted 106 days; the number of swimmers, 10,237; the gross income, $1,436.30.

At Blue Rock Lake the number of swimmers also increased. In 1944 the beach was operated 16 days (Sundays only); the attendance was 2,078, while the gross income was $266.90.

Boating.—Nineteen rowboats were used for hire on Lake Hope in the Zaleski Forest. Rates were unchanged from previous years. Boats were available from the first part of April until the middle of November.

Total receipts from boat rentals for 1944 increased by 42.3 per cent over 1943. Receipts for each of the last 5 years are shown for both boat rental and boat docking in the following tabulation:

Activity	1940	1941	1942	1943	1944	1945
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Boat rental	530.59	1138.38	1316.00	1000.18	1423.79	5409.00
Boat docking	51.65	55.00	37.75	29.50	63.00	236.90

Group camp.—The Tar Hollow Group Camp, which is located 20 miles northeast of Chillicothe, Ohio, was occupied by a lesser number of groups for fewer days, but the number of campers in the groups increased which brought about the same amount of revenue.

In 1944 the camp was occupied 51 days; the attendance was 1,158 adults and 845 children; the number of groups, 8; and the gross income, $1,681.63.

Fig. 41.—The 14 vacation cabins at Lake Hope are in the 22,000-acre Zaleski State Forest.

Vacation cabins.—The 14 vacation cabins located on the Zaleski Forest again broke the use record of the preceding year. This area is no doubt the most popular public-owned and -operated unit in the State and will continue to be so until more are built in some of the other state forest parks. The following statistics show a comparison between 1943 and 1944:

Item	1943	1944
Number of applications filled	385	384
New applicants	541	385
Previous applicants	325	418
Number of renter groups	385	384
Number of renter days	8148	9306
Average number of persons per group	3.78	3.50
Renter groups here previously	127, or 33 per cent	257, or 67 per cent
Receipts from cabin rentals	$6782.74	$8874.23
Direct cost of operation and maintenance	2082.05	2036.82
Number of rentals less than a week	.....	153, or 40 per cent
Number of one-week rentals	.....	200, or 52 per cent
Number of 2-week rentals	.....	31, or 8 per cent
Earliest rental date	April 3	February 24
Latest rental date	December 31	November 26

The increase in funds made it possible to maintain recreational facilities which had been neglected since Civilian Conservation Corps days in 1942. Considerable progress was made, but much remains to be done. Post-war use of recreational areas should result in greater revenue and better maintenance. It should be remembered that no admittance charge is collected and the only source of income is from fees for special services and facilities. Low wartime use means low income, which, in turn, reduces the amount of maintenance which can be done.

Planning.—The chief planning project was the development at Hueston Woods, which includes a 500-acre lake in the basin of Four Mile Creek. Around this lake there would be provision for swimming, boating, camping, hiking, and nature study. This project has much local support and will be undertaken at an early date if funds are appropriated by the Legislature.

Much work has also been done on new forest park purchase units in various parts of the State. These will all be included in the purchase program of the Division of Forestry.

C. E. Bazler

FOREST FIRE PROTECTION

At the close of the year the area included in the forest-fire protection-area totalled 8,424,000 acres. This included all or part of 34 counties. The State protects the 4,939,000 acres of forest and abandoned farm land in this area, with the exception of some 235,000 acres in seven counties which are protected by the U. S. Forest Service. It is within this area that most of the Wayne Purchase Unit is located.

Not all of the 34 counties have sufficient forest fire wardens, but to date 1,878 are on active duty, and many of these have attended two training schools. The warden turnover is very rapid and labor available to the wardens is very difficult to obtain.

The area which should have some forest-fire protection is difficult to determine. A few fires burning over woods, pastures, old fields, orchards, etc., can quickly cause damage much greater than the cost of protection. During the war there have been a smaller number of plowed fields, the lack of which makes sizable fires possible. In northeastern Ohio, in parts of Lake, Trumbull, Summit, Portage, Geauga, Cuyahoga, and Ashtabula Counties, it was found that 60 per cent of the area was covered with inflammable material during several weeks in the spring and fall. Airplane scouting in this territory in the spring of 1943 revealed many acres which had been burned over. Some form of fire control may, in time, be needed in this region.

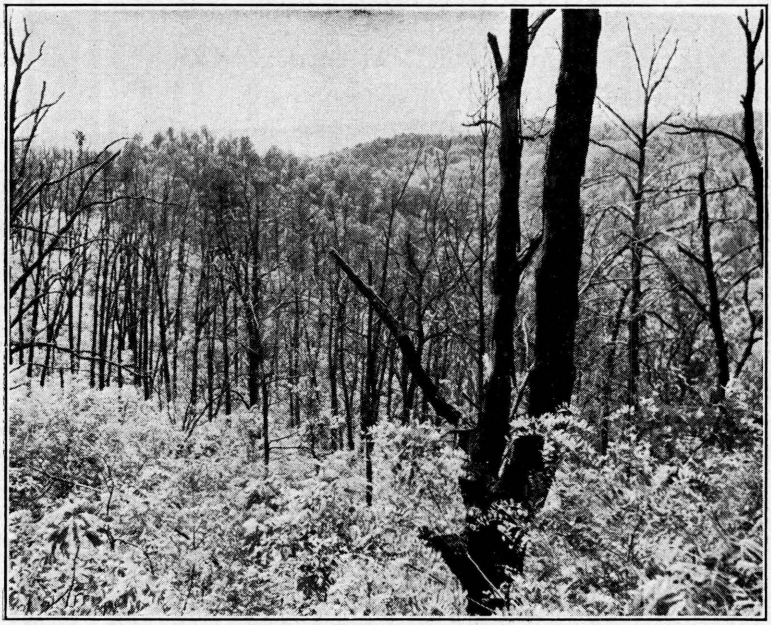


Fig. 42.—Fire-killed timber. It will be 50 years before a crop of trees can be grown on this burn.

Educational work in schools has been carried on by two men with the part time help of a third person. This work appears to be bearing fruit and will be continued.

That part of the Oak Openings in Lucas County was organized and a tower constructed, which was first operated in the fall of 1944. Much educational and law enforcement work will be required in this small area.

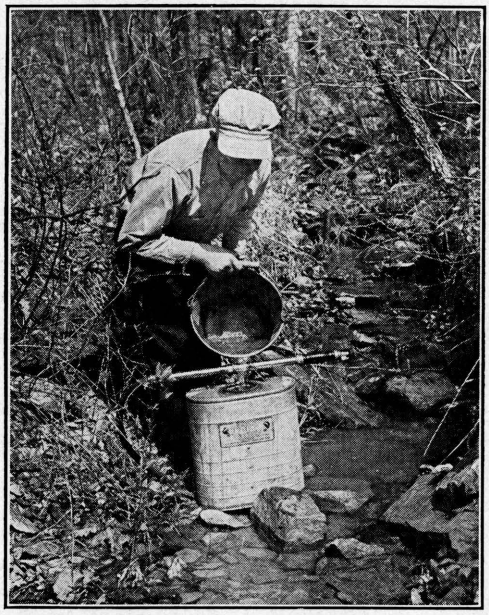


Fig. 43.—Many small streams of Ohio's hill country are dry during fire season. The location of springs and "licks" is important knowledge for the fire fighters.

TABLE 24.—Number of fires, by districts

District	No. of fires	Area burned		Damage	
		Woods Acres	Total Acres	Woods Acres	Total Acres
Fire-tower observation area					
District No. 1	220	2,424.0	4,774.75	3,737.00	7,332.00
District No. 2	184	836.16	2,599.4	3,861.82	10,237.46
District No. 3	3	2.7	2.7	5,036.00	5,036.00
District No. 4	164	2,333.5	3,441.0943	7,019.00	12,498.20
Total	571	5,596.36	10,817.9943	$19,653.82	35,103.66
Airplane observation area					
District No. 1	24	86.0	458.0	184.00	3,804.00
District No. 2	174	902.25	4,250.2	2,395.00	9,344.50
District No. 3	197	1,367.25	7,522.25	6,306.00	15,061.50
Total	395	2,355.5	12,230.45	$8,885.00	27,210.00
Tower and plane observation areas					
All districts	966	7,951.86	23,048.3943	$28,538.82	62,313.66

TABLE 25.—Number of fires during the past 5 years

Fire-tower observation area

Year	No. of fires Spring	No. of fires Fall	No. of fires Total	Class A	Class B	Class C
1940	517	131	648	52	437	149
1941	593	79	642	49	411	212
1942	417	63	480	37	251	192
1943	272	183	455	122	195	138
1944	372	199	571	152	238	181

Year	No. of fires	Acres woodland burned	Average acres woodland per fire
1940	648	3,265	5.04
1941	672	7,203	10.70
1942	480	7,558	15.73
1943	455	2,741	6.02
1944	571	5,596	9.80

Airplane observation area

Year	No. of fires Spring	No. of fires Fall	No. of fires Total	Class A	Class B	Class C
1942	18	26	44	10	14	20
1943	220	131	351	43	117	191
1944	266	129	395	40	148	207

Year	No. of fires	Acres woodland burned	Average acres woodland per fire
1942	44	407	9.25
1943	351	3,445	9.81
1944	395	2,355	5.96

John Bastian

REFORESTATION

The planting season was not very favorable; the early part was cold with frequent rains, followed by a long period of drought. The work in the nurseries was seriously handicapped by frozen ground and prolonged rains. This, coupled with the labor situation, delayed shipments later than was desirable.

Shipping started at Marietta on March 21 and at Wooster on March 23. All shipping stopped at both Marietta and Wooster on May 5.

The orders for trees totalled 1,885,041, which is the fewest trees shipped from our state nurseries since 1926 when 1,533,242 trees were shipped. It is interesting to note that in that year (1926) there were 31 species shipped and that the principal species were Norway spruce, Scotch pine, black locust, and red oak. These four species totalled 1,025,540. This year, the four leading species

were red pine, white pine, black locust, and tuliptree. There were twenty-four species of trees shipped, but the afore mentioned four species totalled 1,367,369 trees.

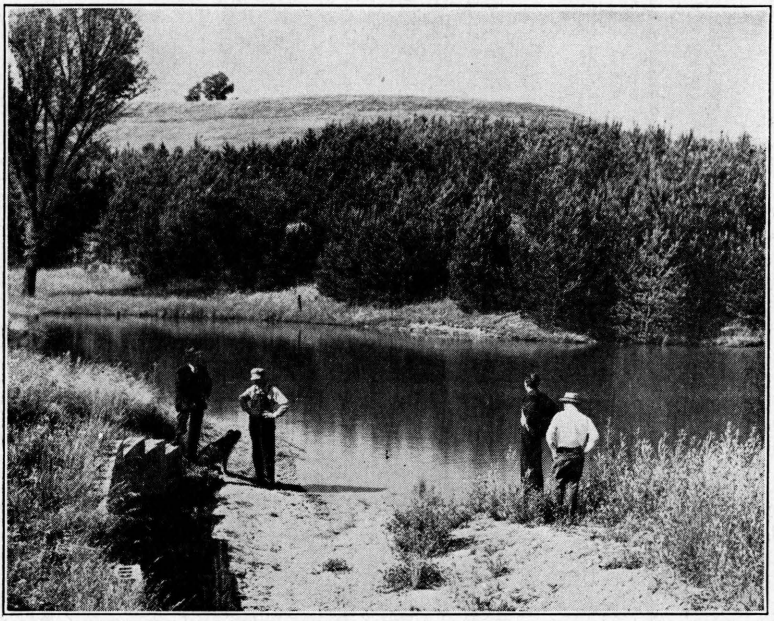


Fig. 44.—Plantation of pine on shore of a farm pond. Such spots offer ideal protection for wild life.

This year there were 1,187 cooperators; whereas in 1926 there were only 374. Excluding the 4-H and Vocational Agricultural students, there were 586 cooperators who received 1,758,854 trees this year. It seems evident that there is some increase in the amount of interest in planting since the start of the Clarke-McNary cooperation, since approximately the same number of trees previously distributed went to many more cooperators. The shipments this year were 28 per cent below those of 1943, but the number of cooperators was only 5 per cent below those of last year.

The number of trees, by species, that were shipped is shown in table 26. The pattern of distribution remains essentially the same, most of the trees going into the northeastern quarter of the State.

The distribution of trees to the different classes of cooperators is shown in table 27. As shown in this table, the farmers, as a class, have been the biggest planters. The trees planted by the State include those (424,925) distributed by the Division of Conservation and Natural Resources, most of which were planted on private lands.

TABLE 26.—Species and number of trees distributed in 1944

Species	Number	Total
Conifers		
Red pine, 3-0*	29,000	
Red pine, 2-2	252,835	
Red pine, 2-3	445,099	726,934
White pine, 3-0	28,000	
White pine, 2-2	136,100	
White pine, 2-3	122,754	286,854
Austrian pine, 3-0		46,624
Shortleaf pine, 2-0		66,224
Jack pine, 2-0		29,500
Loblolly pine, 2-0		6,024
Jersey pine, 2-0		1,000
Norway spruce, 3-0	42,360	
Norway spruce, 2-1	22,548	
Norway spruce, 3-4	50	64,958
Black spruce, 2-2-2		1,050
Red cedar, 2-0		4,648
Hemlock, 2-2	46,798	
Hemlock, 2-4	73,448	120,246
White spruce, 3-4		10
Total conifers		1,354,072
Hardwoods		
Black walnuts, nuts	65,000	
Black walnuts, 1-0	5,650	70,650
Tuliptree, 1-1		79,656
Black locust, 1-0		273,925
Red oak, 1-0	27,350	
Red oak, 2-0	14,962	42,312
White oak, 1-0	7,350	
White oak, 2-0	16,562	23,912
Swamp white oak, 2-0		11,412
Burr oak, 1-0		5,212
White ash, 1-0		5,700
Cottonwood, cuttings		10,600
Sweet gum, 2-0		2,802
Kentucky coffee tree, 2-0		1,750
Beech		3,038
Total hardwoods		530,969
Grand total		1,885,041

*Refers to age of stock. Trees stood 3 years in nursery seedbed and were not transplanted. Trees marked 2-2 stood 2 years in the seedbed and 2 years in transplant row.

TABLE 27.—Number of trees by class of cooperators

Number		Class	Number	
1944	Per cent gain or loss from 1943		1943	Per cent gain or loss from 1943
514	—14	Farmers	873,427	—33
463	— 1	Vocational Agricultural Students	89,750	0
138	+ 9	4-H Clubs	25,600	+ 7
10	0	Institutions	18,826	—18
12	+ 9	Mining	194,000	—22
13	—13	Organizations	32,000	— 6
9	0	Scouts	28,800	+20
10	— 9	State	524,278	—21
9	—10	Municipalities	99,360	—58
1178	— 6		1,885,041	—30

Table 27 also shows the gain or loss in number of cooperators, as well as the number of trees distributed in 1944 as compared with 1943, using 1943 as a base.

The farmers have been the class showing the greatest loss in number of cooperators and also in the number of trees purchased, with the exception of municipalities. There was some increase in the number of 4-H Clubs and mining companies cooperating and some gain in the number of trees planted by scouts and 4-H Clubs.

Robert R. Paton

FOREST TAX PROGRAM

During the past year a report was sent to each County Auditor showing the names of all forest tax cooperators in their respective counties. They were asked to correct the list and to return a copy to the State Forester's office. This gave the first complete record of changes in ownership of lands classified under the Ohio forest tax law. Most of the counties showed little change, but in others there had been a number of transfers. In some instances, the Auditors also pointed out errors in descriptions, acreage, or titles.

These lists have been corrected during the year and are now completed for the most part. It is planned to send the Auditors this list annually. This policy will result in a greater number of withdrawals, but it will make the records more accurate.

During the past year, 77 new certificates were issued; these were distributed over 29 counties and comprised 3,517.83 acres. This is an average of 45.6 acres per certificate.

Disregarding minor discrepancies, there have been 802 certifiicates issued, comprising 57,145.84 acres in the 19 years that the forest tax law has been in effect; of these certificates there are 562 now in effect, comprising 38,747.36 acres. This is an average of 68.9 acres per certificate.

Robert R. Paton

TIMBER MARKETING IN THE MIXED OAK FOREST AREA OF OHIO

Early in 1944 the Station inaugurated a research project on timber marketing; The Department of Rural Economics and Rural Sociology and the Department of Forestry are cooperating in this study. The area being studied lies mainly in the mixed oak forest area of east central Ohio.

Present timber production tends to be from the larger woodlots. Although the average size of woodlot in the area is approximately 19 acres, one-half of the woodlots from which timber has

been sold during the past 5 years averages 40 acres or more and one-half of the timber production in the area has been from woodlots of 50 acres or more. A substantial proportion of the average, or smaller-sized, woodlots either contains little merchantable timber or the owners are reserving the supply for possible home use.

Approximately three-fifths of the woodland owners so far interviewed had relied mainly on competition among buyers to insure a "Fair" price for their timber. Quite often owners had little knowledge of the volume and quality of timber sold, accepting a lump-sum price (the highest bid) for the total quantity marketed.

Approximately two-fifths of the timber sales were based on one bid only. In part of such cases some attention was given by the seller to the quantity and quality sold. Sometimes, however, a neighbor had disposed of a similar tract at a certain price and this was used as a measure of value. Also, included in this category are some sales by log-scale and mill-run measurements at prices currently accepted as standard in the area. In one-third of the cases, sale was based on a more or less methodical cruise of the timber.

The contacts so far made in this study suggest that the failure of woodlot owners to obtain adequate information on the quantity and quality of their marketable timber has often resulted in sales at relatively low prices. Another cause for low prices is the sale of over-age stands—trees that have passed their prime and are now defective.

H. R. Moore and O. D. Diller

PRESERVATIVE TREATMENT OF FENCE POSTS[10]

In January 1944, 105 posts of three species (namely, American elm, shortleaf pine, and soft maple) were obtained from the Zaleski State Forest for an experiment in determining the lasting qualities of different species of wood under different preservative treatments when in contact with the soil.

These posts were 4 feet long with an average top diameter of 5 inches. All the posts were peeled and seasoned for 6 months before treatment. In June, all the posts, excepting the controls, were taken to Orrville for treatment which consisted of the pressure, hot-cold open tank, and cold dip methods, using creosote, copper naphthenate, and copper tallate. Each post was given a number and the net absorption and cost of preservative determined.

[10]In cooperation with the Nuodex Products Co., Inc., Cleveland, Ohio, and the Koppers Company, Orrville, Ohio.

After treatment the posts were planted in a fence row at the Experiment Station during August 1944. Plans are to make an annual inspection of the posts for a period of at least 15 years.

O. D. Diller

BLIGHT-RESISTANT CHESTNUTS[11]

During the years 1915 to 1943, beginning even before the chestnut blight attacked the native American chestnut in eastern Ohio, the United States Department of Agriculture distributed Asiatic chestnut trees to various cooperators within Ohio. This was for the purpose of determining their adaptation to our soils and climate and their relative value as orchard and forest trees. From 1930 until 1943 nearly 17,000 seedlings were distributed in Ohio, mostly through the Department of Forestry of the Ohio Agricultural Experiment Station. Because of the severe drought in the early thirties and the frequent planting on unfavorable sites, the farmers lost most of these trees during the first and second year after planting. But in some cases, they have become established, have been making satisfactory growth, are proving blight-resistant, and are yielding large crops of nuts. Since blight-resistant chestnut trees are now available in the trade, Department distribution has been discontinued except to research institutions for cooperative experimental work.

During the spring of 1939, 983 Asiatic chestnuts were planted on two hillculture areas near Seneca Lake, Senecaville, Ohio. During the fall of 1944 these trees were checked for their general condition, growth, survival, and production of nuts. The data show that there has been a survival of 84 per cent. Average height per tree, average number of burrs and nuts per bearing tree, and average number of nuts per pound, by varieties, are shown in table 28.

TABLE 28.—Average height per tree, average number of burrs and nuts per bearing tree, and average numbers of nuts per pound, by varieties

Variety	Average height	Average burrs per tree	Average nuts per tree	Average nuts per pound
	Ft.	*No.*	*No.*	*No.*
Castanea crenata FP-720	6.3	16	33	83
Castanea crenata FP-45	6.5	10	22	58
Castanea mollissima T-21	5.2	11	18	66
Castanea mollissima FP-719	6.5	8	22	86
Jap-chinquapin hybrid	5.9	24	30	97
All varieties	6.2	15	28	78

O. D. Diller

[11]In cooperation with Division of Hillculture Research, Soil Conservation Service; Division of Forest Pathology, Bureau of Plant Industry, Soils, and Agricultural Engineering; and Muskingum Conservancy District.

FARM FORESTRY

In cooperation with the Norris-Doxey program of the U. S. Department of Agriculture, two farm forestry projects have been initiated in Ohio. Trained foresters have been stationed at Chillicothe and Wooster, and they cover a combined area of 11 counties.

The duties of these men include assistance to the farm woods' owner in the measuring and marketing of his merchantable timber, planning the management of farm woods, and helping the operator find the kind and quantity of standing timber needed.

Much of the time of these men has been spent assisting the War Production Board by stimulating the output of certain products urgently needed in the war effort.

Keeping sawmills in operation has been a problem for many operators who were at a loss how to obtain equipment and supplies. They also had difficulty in obtaining draft deferments for their key personnel. The farm foresters assisted in the solution of these problems.

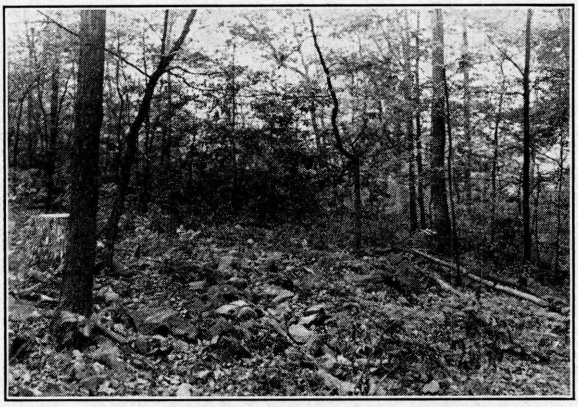


Fig. 45.—Selective cutting is being practiced by many private timber owners. Immature trees are saved for the next cutting.

The Timber Production War Project was organized by the WPB and operated through the U. S. Forest Service. Other foresters were appointed until most of the State was within reach of one of these men.

The results have been beneficial to timber owner and operator alike. Much young timber has been saved, old-growth trees have

found their most appropriate market, and, in some cases, trees of poor quality were removed from a woods and put to some needed use.

Provision should be made for a state agency to take over much of this work after the war, as an effective means of obtaining desirable forest practices without recourse to legislation.

O. A. Alderman

PUBLIC RELATIONS

Most of the public relations and educational work of the Division has been in the branch of forest-fire control. Two men have spent nearly full time visiting schools and lecturing to high school students, many of whom are enrolled in the Forest Fire Fighters Service.

Throughout many counties in the forest-fire district exhibits were prepared for the county fairs. An exhibit was also prepared for the Sportsmen's Show at Cleveland, which was viewed by approximately 150,000 people.

Many lectures were made before service clubs, garden clubs, and various kinds of conservation clubs, granges, etc.

Several meetings were attended where the initiation of a state forest or forest park was the point of interest. In this connection the efforts of people in the Cleveland area to save the Crile forest represent an example.

Much interest is developing in southwestern Ohio in the Hueston Forest Park, for which preliminary plans were prepared by the Branch of Recreation. It is quite likely that a request for funds for this project will be made by some of the members of the Legislature from that region.

James D. Wells

SAWFLY DAMAGE TO FOREST PLANTINGS

During the past few years, young pine trees used for reforestation have been damaged seriously by insects in many sections of the State. The chief offenders have been the larvae of several species of sawflies. Usually only a part of the planting is attacked but, occasionally, practically every tree in areas several acres in extent is defoliated.

The eggs of most sawflies hatch early in the season before the new growth starts. At first, the young larvae feed on the surface of the needles but after they attain more size the entire needle is consumed. Rarely is the new growth attacked, even if all the old needles are destroyed.

Fig. 46.—Scotch pine defoliated in early May by the European pine sawfly, *Neodiprion sertifer* Geof.

The majority of the sawflies that attack pine, produce but one brood per year. Most of the one-brooded species are only mildly injurious because the new crop of needles sustains the tree; thus, a planting may suffer defoliation of the old needles in early spring for 2 or 3 years in succession with no more serious effect than a somewhat lowered vitality. A few Ohio sawflies develop a second brood in the fall and when sufficiently abundant, again denude the trees. Such trees die. Plantings of white pine in particular, as well as red, shortleaf, and some of the others, should be observed occasionally in late summer and early fall for developing sawfly outbreaks.

The preferred treatment for controlling pine sawflies in forest plantations is a mixture of 1 pound of calcium arsenate and 9 pounds of a fine-particle-size grade of hydrated lime applied in dust form. Maximum benefits follow applications made when the larvae are small.

J. S. Houser

Turf and Ornamentals

SINOX KILLS BUCKHORN

One of the most common and troublesome lawn weeds in most parts of Ohio is narrow-leaved plantain, or buckhorn, (*Plantago lanceolata*). If prevented from seeding, an infestation will not persist indefinitely since in the latitude of Ohio, at least, the plants are relatively short-lived perennials. Development of seed, however, is difficult to avoid by cutting the grass with a lawn mower because of the rapid rate of growth of the buckhorn seed stalk. Under favorable conditions it may elongate as much as 1 inch or 1½ inches per day. If seeds are allowed to mature, the infestation may continue without ceasing, for a single plant, under favorable conditions, may produce a thousand or more seeds per year.

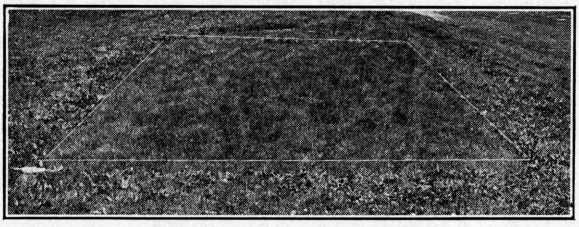


Fig. 47.—Sinox kills buckhorn

If the stand of buckhorn is thin, hand weeding is practical. Midsummer is the most effective time to remove them because the plants are lower in the ground then than in either spring or fall. If the roots cling to the soil and cutting is necessary, the cut should be made to a depth of at least 1 inch.

If the stand is thick, hand weeding is too slow and laborious. Then a more efficient way is to treat with various chemicals.

Both plants and seeds can be killed with a relatively new chemical sold under the trade name of Sinox. One application of a 2 per cent solution applied at the rate of 10 gallons per 1000 square feet may kill 95 or more per cent of the plants. Two applications 3 or 4 weeks apart will kill practically all of them. Sprayings are best made in the cool weather of spring and fall. Sinox imparts an orange color to the grass which may persist for 2 or 3 weeks. This

period of discoloration may be shortened materially by watering the treated area 2 or 3 hours after treatment. This area inclosed by the string shown in figure 47 was sprayed June 7 and again on July 3, 1940, and was photographed June 18, 1941.

F. A. Welton

CONTROL OF WHITE GRUB IN BLUEGRASS PLOTS

Bluegrass plots on Wooster silt loam, which was treated with various amounts of lead arsenate in 1935, continued to show effective white-grub control in 1943 without any subsequent treatment. From five 8-inch circular samples taken on each of the eight replications for all treatments, it was found that 5 pounds of lead arsenate applied to 1,000 square feet had reduced the grub population 50 per cent; 10 pounds, 81 per cent; 20 pounds, 90 per cent; and 30 pounds, 97 per cent.

The effectiveness of the lead arsenate treatment was not impaired when the arsenical was mixed with various organic and inorganic fertilizers immediately before application.

C. R. Neiswander

DISEASE CONTROL

Aster Wilt

China asters, which have been selected for the past 3 years for wilt resistance, were grown last season in soil heavily infested with several isolations of the aster Fusarium-wilt fungus. A number of these selections proved highly resistant to wilt under cloth-house conditions.

Several selections of a purple royal variety were free of wilt when grown in soil where over 90 per cent of susceptible varieties were killed by the disease. Strains of white and pink royals, rose American branching, and rose Crego, after being selected for resistance for 3 years, were fairly resistant but not as much so as the purple royal variety.

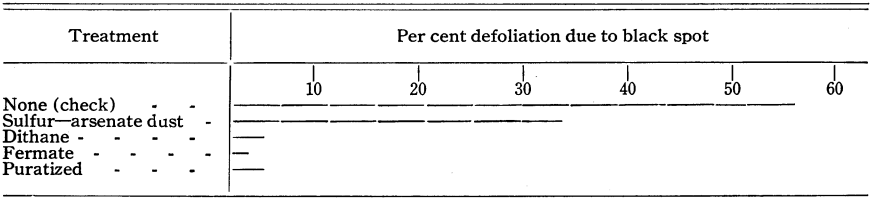
Tests by florists have shown some of these resistant selections to be good commercial cloth-house varieties, when they are given additional artificial light in the seedling stage to bring about early blooming.

Paul E. Tilford and H. A. Runnels

Rose Black Spot

Some of the new organic fungicides were experimented with for the control of black spot of roses during the summer of 1945. A row of Pink Radiance roses was divided into five plots so that each plot had either two or three plants. One plot was left untreated throughout the season to serve as a check. Sulfur-arsenate dust (90-10), Dithane (2 pounds to 100 gallons), Fermate (2 pounds to 100 gallons), and Puratized (½ pint to 100 gallons) were used as treatments on the remaining four plots. Du Pont Spreader was used with each of the spray treatments.

Treatments were made on the following dates: June 15, June 23, July 7, and July 17. There was very little rainfall during July and August; therefore, no treatments were made after July 17. At that time there was very little black spot on any of the plants, even in the check plot. In September, following light rains, black spot began to appear and counts were made on October 7 to determine the amount of defoliation caused by the disease on plants which received the different treatments. These results are shown in the following graph:



Puratized was the only material that injured the roses. The spray containing Puratized stunted the new growth and caused chlorosis and mottling of young foliage.

Paul E. Tilford

THE CULTURE OF GREENHOUSE ROSES

Pinching Tests

Results of pinching tests on newly planted started-eye plants of Better Times roses showed that soft pinching is the best method to use in developing a well branched plant. Thirty-three per cent more "bottom breaks" were produced by the plants that were soft pinched than by those that were hard pinched.

Spacing Tests

Results of the spacing tests on greenhouse roses substantiate the results of 1943. The 12-inch by 12-inch planting distance produced more flowers per square foot of bench than did any of the other spacings. Roses planted 6 inches in the row and 18 inches between rows gave good production, but the ease of cutting, pinching, syringing, spraying, and tying was hindered.

Use of 4-year Plants

Four-year plants were removed from the bench, placed in a storage at 40° F. for 3 weeks, the roots kept moist by packing them in sphagnum moss, and then replanted. This treatment produced exceptional vigor, and such a treatment enables commercial growers to maintain production even though young plants are not available for purchase in sufficient amounts to meet the present demand.

Keeping Quality

Keeping quality tests showed that the use of "Bloomlife" and "Floralife" in the cooler does not lengthen the time the flowers will last when the roses are removed from the cooler and placed in water in the home. The use of these materials in containers in the home does increase the keeping quality, but treatment in the cooler is not necessary and does not produce a residual effect.

Alex Laurie

INDUCEMENT OF EARLY FLOWERING OF GARDENIAS

A Christmas crop of gardenias is difficult to produce under Ohio conditions because of the extreme heat in September when flower bud initiation occurs. As a result of 3 years' trials it was shown that a **reduction of the photoperiod** by shading the plants with black cloth from 5 p. m. to 7 a. m. from July 21 to August 15 (a period of 3 weeks) resulted in the production of 6-10 flowers per plant during the Christmas period. Check plots produced 0-2 flowers.

Nutritional variations failed to affect flower bud initiation.

Subbirrigation is a labor-saving device and is practical in the culture of gardenias in benches.

Gravel culture produced better quality bloom and increased production over soil-grown plants. Forty flowers per plant were produced on 2-year-old plants in soil and 65 flowers per plant in haydite or cinders.

Alex Laurie

PROPAGATION OF CHRYSANTHEMUMS

Tests of methods of handling chrysanthemums previous to benching justify the following conclusions:

a. Potting unrooted cuttings in light, well-drained soil and then shading and syringing them to prevent wilting constitute the easiest and most economical method of handling chrysanthemums. This eliminates any checks in growth.

b. Planting rooted cuttings direct to the bench is satisfactory in most cases, except for a tendency to check growth unless conditions for growth are ideal.

c. Fertilizing rooted cuttings in the propagation bench eliminates hardening of the stem, but it increases the variation of the plants at the time of benching and causes a definite check in growth.

d. Potting rooted cuttings is a waste of time and labor and should be resorted to only when plants have to be held for a period of time before benching.

Alex Laurie

EFFECT OF PHOTOPERIOD AND TEMPERATURE ON THE FLOWERING OF AZALEAS

The reduction of the length of the photoperiod in combination with cool temperature or cool temperature alone will precondition the Coral Bell azalea for early forcing (fig. 48). The plants should

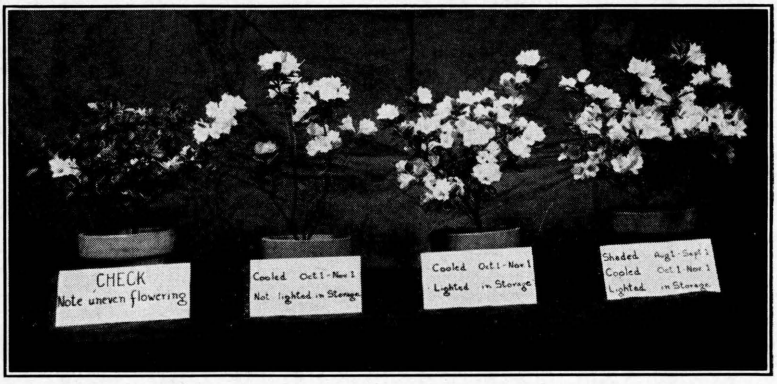


Fig. 48.—Azalea Coral Bells photographed December 18, 1943. From left to right:

Check—note uneven flowering.
Cooled October 1 to November 1, not lighted in storage; note leafdrop.
Cooled October 1 to November 1, lighted in storage.
Shaded August 1 to September 1, cooled October 1 to November 1, lighted in storage.

be shaded with black cloth during August from 5 p. m. to 7 a. m. and placed in a lighted (50-foot candles) storage at 40-50° F. during October. A dark storage will cause leafdrop as is shown in figure 48. The plants may be forced for Christmas by placing them in a light greenhouse with a temperature of 60° F., allowing 4 weeks until full flowering. The shading appears to induce somewhat more uniform plants, but in commercial practice, the cooling treatment alone in October will produce excellent plants. Further tests for earlier forcing on Coral Bells and other azalea varieties are in progress.

Alex Laurie

FLOWER BUD DIFFERENTIATION IN HYDRANGEAS

The use of leafbud cuttings for the production of hydrangea plants showed that leafbud cuttings taken at the same time as normal stem cuttings produce fully as satisfactory a plant. This is clearly shown in figure 49; here the variety Europa was propagated in early March. "Blindness" of shoots is eliminated by providing partial shade (lath) outdoors until August. Removal of the shade then increases photosynthesis, accumulates carbohydrates, and induces flower-bud initiation early.

Fig. 49.—Europa hydrangea propagated in early March. Left—stem cutting; right—leafbud cutting.

Alex Laurie

THE PROPAGATION OF WOODY ORNAMENTALS

Propagation studies have dealt with humidity control, the use of leaf-bud cuttings, and the kinds of cuttings for successful rooting of Better Times roses.

Humidity has been controlled by use of compressed air and water. In this system, air is passed over a column of water, thus creating a suction and forcing the water through a special Binks nozzle in the form of a fine mist. In the tests to date, there has been little advantage from extremely high humidity with narrow-leaf evergreen cuttings. Seventy to 75 per cent humidity seems ample. Under such conditions, sand has proven a better medium than mixtures of sand and peat. Maintenance of high humidity has made it possible to handle many softwood shrub cuttings in the greenhouse during the summer, where formerly it was necessary to handle them in outside frames. Of the 45 species and varieties of plants used, cuttings of 24 rooted best at a humidity of 85 to 90 per cent, 4 rooted best at a humidity of 65-70 per cent, and 17 rooted equally well in either humidity.

Leaf-bud cuttings of 45 species and varieties of deciduous shrubs were compared with softwood standard stem cuttings. Twenty-seven types showed best response from stem cuttings, nine gave best response from leaf-bud cuttings, and nine types were indifferent. Leaf-bud cuttings will be of value in propagating several plants when propagating wood is scarce and for a few types not rooting readily from stem cuttings.

The difficulty experienced in obtaining budded roses has forced many rose growers to attempt to propagate their own plants by cuttings. This has often resulted in failure. To determine the best technique to follow in handling rose cuttings, five types of cuttings were made and placed in mediums of sand and haydite and held at humidities of 75 and 60 per cent.

Data compiled indicate the best rooting from three-eye stem cuttings held at the high humidity (75 per cent). One hundred per cent rooting, with very good quality of roots, was obtained in this treatment. Two leaves were left on each cutting and only the end leaflets were trimmed. Blindwood was harder than the flowering wood and it produced the better cuttings. Growth substances and subirrigation were tried with no significant results.

L. C. Chadwick

Agricultural Engineering

FARM FREEZE PLANT

Refrigeration is fast becoming a tool for agricultural food preservation. Insulation materials are an important factor in refrigeration storage rooms.

Two 8 by 10-foot (inside dimensions),—35° F. walk-in refrigerators are being studied. One is insulated with 6 inches of a standard blanket-type insulation; the other is insulated with planer shavings. The space between the inner and outer walls of the latter room is wide enough to permit the removal of the shavings if they should deteriorate. However, after one year the shavings are still in good condition. The outer walls of both units were vapor sealed; whereas the inner walls were constructed so as to leave cracks.

In addition, a box 2 feet square was built to fit into an outer box in such a way as to leave an 8-inch space on all sides between the two boxes. The space within the inner box is kept at a temperature of 115° F. Different kinds of insulating materials are placed between the boxes, and records are kept of the energy consumption required to maintain the inner temperature (115° F.) when the temperature outside the unit is maintained at 90° F. Comparisons have been made with a standard insulating material versus straw and sawdust. Other materials are to be studied, including shavings, ground corncobs, sawdust, concrete, etc.

W. A. Junnila

VENTILATION OF EAR CORN AND GRAIN

The study of ventilation of shelled corn by means of flues, and also by forced ventilation with natural air, was continued in 1943 and 1944 at the University Farm, Columbus, Ohio. Reports were made in Bimonthly Bulletins Numbers 219 and 220.

The use of horizontal flues for both drying ear corn in cribs and shelled corn in a round steel bin was continued in 1943 and 1944. The results are so successful that mimeographed publications were prepared for distribution to farmers for instructions on

how to prevent spoilage of damp grain and corn in the 1944 and 1945 season. These publications are titled: "Forced Ventilation in Drying Corn, Grain, or Soy Beans" and "Ventilation of Farm Cribs and Bins to Preserve and Condition Ear Corn and Grain."

The studies indicate that ear corn containing 35 per cent moisture may be stored successfully in cribs equipped with horizontal flues. Even shell corn containing 20 per cent moisture when shelled and stored in a flue-ventilated bin in November was in good condition up to May 1 in 2 year's trial. The shelled corn was dried with forced ventilation during May and June.

R. C. Miller

FORCED VENTILATION OF PARTIALLY CURED HAY IN MOW OR STACK

The studies on the ventilation of hay in the mow with forced ventilation were started in 1939 at the Anderson Farm, Maumee, Ohio. The hay was chopped at the mow in 1939. In 1940 and 1941 a field chopper was used. In 1940 studies were also conducted on the Wood Farm east of London, Ohio, where long hay was cured with forced ventilation. In 1941 the dairy barn at The Ohio State University was equipped with a large main tunnel and laterals made in sections. In 1942 the beef barn was similarly equipped. Studies in cooperation with the University Farm and the Agronomy Department have been conducted there every season. The results of these studies are reported in the Journal of Agricultural Engineering for May 1943.

In 1943 and 1944 the studies were continued and extended to a small installation at the dairy barn at the Experiment Station, Wooster, Ohio. This is in cooperation with the Dairy Industry Department.

A mimeographed publication[12] giving the basic principles for design and operation of hay driers for Ohio farms was prepared in 1944 for distribution to inquirers. The publication includes some reprints of previous studies. The studies are being continued.

R. C. Miller

[12] "Forced Ventilation of Partially Cured Hay in Mow or Stack," by R. C. Miller, May, 1944.

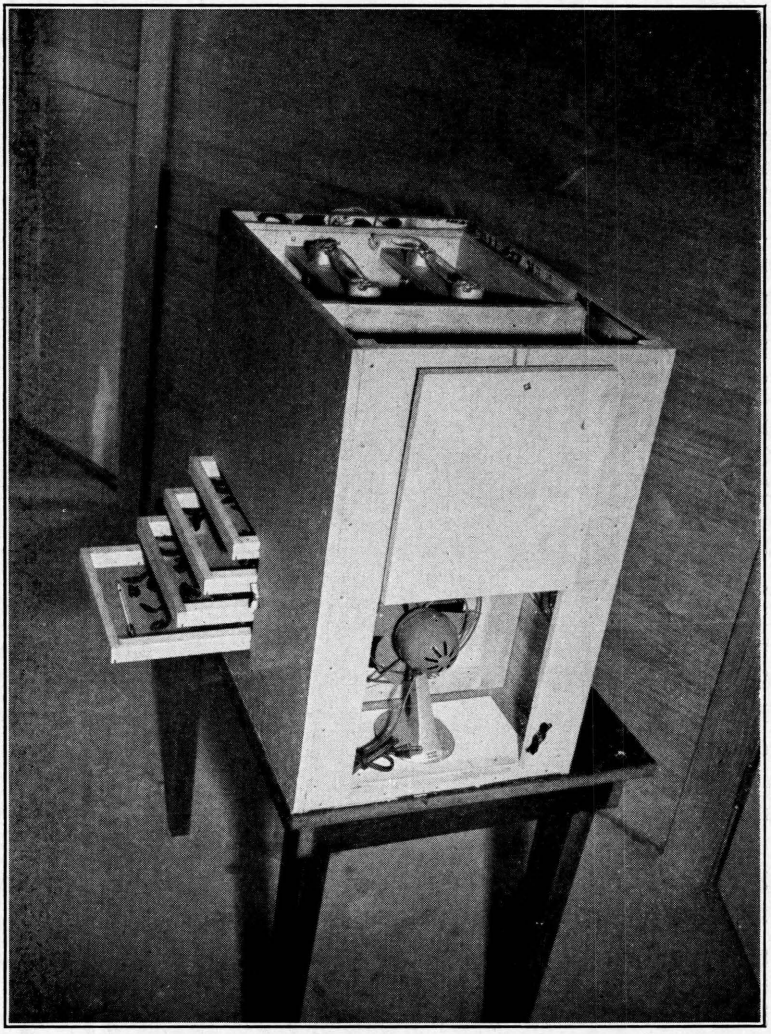


Fig. 50.—An inexpensive home dehydrator constructed of ½-inch insulating board. Mazda lamps and a common household fan were used in this model.

HOME AND INSTITUTIONAL FOOD DEHYDRATION

The departments of Horticulture, Agricultural Engineering, and Home Economics cooperated in designing four types of small home dehydrators and two large types of institutional dehydrators. These were tested for their effectiveness and usefulness in homes and public institutions of Ohio.

The four home-types of dehydrators were electrically heated and the air was circulated by means of fans. Some of the fans were of home construction and attached to any available motor; others were of the conventional portable type with blades mounted on the motor shaft. The electric motor for operating the fan and the electric heating elements were the only parts which could not be fabricated at home.

Figure 50 shows a view of one of the simpler types of home dehydrators. This one used several Mazda or drying lamps for heat and was ventilated by an ordinary household fan. This dehydrator was developed in cooperation with the General Electric Company, Nela Park, Cleveland, Ohio.

The Institutional Dehydrators were constructed and operated in a County Home in the State where several tons of potatoes, sweet corn, table beets, and cabbage were successfully dehydrated.

Working drawings, material lists, and descriptions of all these dehydrators are available for distribution to the residents of Ohio.

A more complete discussion of this project will appear in the Bimonthly Bulletin of the Ohio Experiment Station for July-August, 1945.

Donald Comin, W. A. Junnila, and Mary B. Patton

Textiles

SELECTION OF SEWING THREAD[13]

Unmercerized cotton sewing thread, mercerized cotton thread, heavy duty mercerized cotton thread, and nylon thread were tested. Heavy duty thread was outstanding in single strand strength, and it was the strongest when made up into seams, nylon thread being next highest in seam strength. Elongation at break was much greater for nylon thread than for any cotton thread, and 6-cord cotton thread had slightly higher elongation than 3-cord unmercerized cotton thread. In general, unmercerized cotton thread had the best balance of twist and caused least difficulty in hand sewing, while mercerized cotton thread and nylon thread were most poorly balanced and caused the greatest difficulty in hand sewing. Thread characteristics which varied considerably among different brands of the same type of thread were price, balance of twist, seam strength, ease of use in hand sewing, and colorfastness to laundering. The only consistent relationship of price to quality of a given type of thread applied to 6-cord thread, the lowest priced brand being the weakest and having the lowest elongation. Some useful information was supplied on labels of most of the thread tested.

Florence E. Petzel

COTTON AND RAYON FABRICS USED FOR GLASS CURTAINS[14]

A comparison was made of the probable durability and serviceability of 36 cotton and rayon glass curtain fabrics. They included cotton voile, scrim, marquisette, bobbinet, and filet; also, rayon voile, ninon, and marquisette.

In general, cotton glass curtain fabrics gave evidence of being more durable and serviceable than rayon fabrics of similar construction because of their greater dry strength, gain in strength when wet, and smaller loss in strength after laundering. There

[13]A report on the project "Factors Relating to the Selection of Sewing Thread" was published in Bulletin 649, March 1944.

[14]A report on the project "A Comparative Study of Cotton and Rayon Glass Curtain Fabrics" was published in Bulletin 645, October 1943.

was some relation between price and breaking strength, especially in the low and medium priced ranges. However, the most expensive fabrics were sometimes made of such fine yarns that they were weaker than lower priced fabrics. Effects of exposure to light varied with individual fabrics, loss in strength being appreciable in fabrics exposed at north windows. Except for acetate rayon, all fabrics lost more strength when stretched than when ironed. Of the rayons which were ironed, viscose voile lost the least strength and cellulose acetate ninon the most. When stretched, cellulose acetate lost less strength than viscose or cuprammonium rayon. Upon exposure to light the three fabrics which changed most in hue were cellulose acetate rayons. The colorfastness to light of cotton marquisette and filet and colorfastness to laundering of cotton marquisettes had some relation to price. There was appreciable shrinkage in most fabrics, especially in marquisette and bobbinet. Price was not closely related to shrinkage.

Florence E. Petzel

A COMPARISON OF PART-ARALAC FABRICS WITH ALL-WOOL AND ALL-RAYON FABRICS

Similar types of twill fabrics, such as serge and flannel, have been selected for comparison. These fabrics vary in fiber composition, being part-Aralac, all-wool, or all-rayon. Tests have been started with the object of obtaining information on the probable serviceability of these fabrics.

Florence E. Petzel

Japanese Beetle

BEHAVIOR OF THE JAPANESE BEETLE IN OHIO

During the 3 years that the Japanese beetle, *Popillia japonica* Newm., has been studied intensively under Ohio conditions, it appears that, with one notable exception, the insect behaves much the same as it does in the eastern part of the United States.

This exception is the failure of the insect to increase to harmful numbers in some areas where it is known to have been present for several years.

Fig. 51.—Foliage and fruit of apple being damaged by Japanese beetle

The one area of this sort about which most is known is Columbus, Ohio. Several other areas might be cited also. Although beetles were taken as early as 1931 in Columbus, the insect has made such little headway that it is a scarce insect and no perceptible damage has been done. During approximately the same period of time, the Japanese beetle has increased prodigiously in Bratenahl, Youngstown, and North Salem.

The factors responsible for this difference in behavior are a matter of conjecture. It is suspected, however, that soil type and summer rainfall, especially during late June and throughout July, are important. Winter temperatures and the presence or absence of a snow blanket likewise may be contributing factors.

The acquisition of further information on the foregoing, as well as on other phases of the biology of the Japanese beetle under Ohio conditions, is of vital importance in the development of a practical program for its control.

J. B. Polivka

CONTROL OF JAPANESE BEETLE

The Japanese beetle, *Popillia japonica* Newm., has become definitely established in Ohio and can be found in more than 50 localities. Since eradication is impossible, it becomes necessary to determine what can be done to protect the foliage, fruit, and flowers of plants from the ravages of the adult beetles and the roots of plants, particularly turf, from the larvae.

A series of spray plots for the purpose of finding a material to protect foliage indicated that, of the materials used, Fermate containing some derris gave the best protection. Because the latter is not available for general use now, it has been necessary to recommend the best substitute, which is lime. Ordinary lime dusted or sprayed on the plants gave a fair amount of protection. However, the principal difficulty with the material is that it does not adhere to the plants readily, with the result that it must be applied at least once a week or oftener. Therefore, it is advised that lime specially prepared for dusting or spraying be purchased for this purpose. It is not necessary to apply this special lime so often, as it sticks to all types of foliage better than does ordinary lime.

The larvae of this insect can be controlled effectively by the application of lead arsenate to the soil. If this material is applied at the rate of 10 pounds to 1,000 square feet of turf at any time during the feeding period of the larvae it will kill 99 per cent of the population the first year.

There seems reason to believe that ultimately Japanese beetle may be held in check to a considerable degree by its own natural enemies, several of which have been introduced in Ohio. One of the most promising is a bacterium, known as the milky white disease, which attacks the larvae. This disease is being propagated and distributed in those areas of the State in which Japanese beetle has become abundant.

One advantage of the milky white disease is that it can be used in vegetable gardens, as well as on lawns and other areas of turf. Lead arsenate should not be used on soil in which root crops, such as radish, turnip, beet, etc., are grown because such crops are likely to contain harmful amounts of both lead and arsenic.

J. B. Polivka

Bacteriophages

THE BACTERIOPHAGE AS A MEANS OF IDENTIFYING BACTERIA

Plant pathologists frequently find a need for a quick method of identifying bacteria. Inoculation of plants and the use of special culture media have been the routine most often followed. Both of these procedures require considerable time.

The bacteriophage reaction which is based upon the lysis of bacteria or inhibition of growth can be used to advantage for identification purposes. The phage reaction shows remarkable specificity and is easy to use. The same reaction sometimes reveals a relationship between species which was not suspected.

In this study, two groups of organisms were selected: one group, plant pathogens; and the other, human pathogens or species closely associated with them. The phage reaction was found to be useful for species identification with both classes of bacteria.

TABLE 29.—Bacteriophages

Species of bacteria	1	2	3	4	5	6	7	8	9	10
1. *Pythomonas pruni*	4+	—	—	—	—	—	—	2+	—	—
2. Ac-X	—	4+	2+	—	—	4+	—	—	—	—
3. *Erwinia amylovora*	—	—	4+	—	—	—	—	—	—	—
4. *Phytomonas glycineum*	—	—	—	4+	—	—	—	—	—	—
5. *Corynebacterium sepedonicum*	—	—	—	—	4+	—	—	—	—	—
6. *Phytomonas michiganese*	—	3+	—	—	—	4+	—	—	—	—
7. *Phytomonas tumefaciens*	—	—	—	—	—	—	4+	—	—	—
8. *Phytomonas syringae*	—	—	—	—	—	2+	—	4+	—	—
9. *Phytomonas campestre*	—	—	—	—	—	—	—	—	4+	—
10. *Phytomonas fasciens*	—	—	—	—	—	—	—	—	—	4+

4+ signifies complete lysis of a culture, while +, 2+, and 3+ indicate varying degrees of partial lysis. No reaction is represented by —.

In table 29 is shown the response which 10 different species of bacteria give when all are tested against phages specific for each species. All of these organisms are known to cause disease in plants, with the exception of the one designated as AC-X, which is a yellow organism commonly found in fire-blight cankers.

The phage for *Corynebacterium sepedonica* was obtained from a water extract of a dead potato plant which had the ring dot disease. In the cases of the other organisms, water extracts of such grains as oats, rye, wheat, or timothy seed were used. These extracts contain non-specific phage precursors which give rise to specific phages when brought into contact with bacteria. Bacteriophage filtrates will retain their potency for several years if stored in a refrigerator at 5° C.

R. C. Thomas

Soil Survey

REPORT OF THE SOIL SURVEY FOR 1944

The Ohio Experiment Station has continued to cooperate with the Soil Conservation Service and the Bureau of Plant Industry in conducting Conservation Surveys in connection with Soil Conservation Districts. Four Districts were organized in 1942; 12 were in operation in 1943; and the number had increased to 36 in 1944. Complete conservation surveys had already been made in three districts, and fairly recent soil surveys had been completed in seven other counties. Surveys were not available in the other districts. As information on soil, slope, erosion, and land use is considered a fundamental necessity for the work of the districts, the conservation surveys are being made.

In 1944 surveys were underway in 24 counties. Where soil survey maps were available (as in seven districts), supplemental surveys were organized. First inspection was made in 15 counties, and progress inspections were completed in six other counties. First inspections will be required in at least seven new districts early in 1945.

The work of the surveys in 1944 has been confined to individual farms. Because of the limited personnel, it has been impossible to work on the area basis. The surveys have been somewhat generalized (emergency-period surveys) in all but the four original areas, but they are still in sufficient detail to be used in the detailed soil map of the State.

G. W. Conrey

District and County Farms

DISTRICT AND COUNTY EXPERIMENT FARMS

Nine farms owned by as many different counties and five farms owned by the State are embraced in the system of outlying Experiment Farms under the control of the Ohio Agricultural Experiment Station. County Experiment Farms are financed by receipts from farm sales and by county appropriations which by law have an upper limit of $2,000 per year per farm. In addition, the Experiment Station pays a part of the salary of superintendents. District or special crop experiment farms are financed from funds appropriated to the Experiment Station by the state legislature. One farm is largely operated and financed by the U. S. Soil Conservation Service.

Apple orchards are maintained on six of these farms; three farms have dairy cows as an important project; three have sheep; four devote major livestock energies to beef cattle; and one to chickens. Tobacco is grown on one farm and sugar beets on two farms. All farms are available for such experimental tests as may seem desirable and for which facilities may be available. The tabulated list for all the outlying farms is quite comprehensive with projects in soil management, crop varieties, meadow mixtures, livestock feeding and breeding, disease and insect control, and such miscellaneous problems as may arise at various times.

M. A. Bachtell

For work at specific farms see *also* Index—District and County Experiment Farms

Weather

OHIO WEATHER SUMMARY FOR 1943

Weather data gathered at the Wooster Station during 1943 constitute the 56th continuous year of these records and furnish some unique and interesting contrasts with previous records and averages for the entire period. In 10 months of 1943, temperatures were below the 56-year average and only the years 1888, 1904, 1917, and 1940 were colder. The 1943 April was the coldest on record, being 7.2 degrees below the average. June was 4.1 degrees warmer than average. Four daily temperature records were broken, March 3rd and 4th, with 0 and 1 degree above zero, respectively, as all time low; March 31st produced an all time high of 71 degrees for this date; and 39 degrees was the lowest ever recorded for July 1st.

The year ended with a deficiency of almost 8 inches of precipitation. Ten of the 12 months were below average. May, with 2.54 inches above the average, was the wettest May in 50 years; whereas June was the driest on record, with a deficiency of 3.03 inches. Of the past 56 years, 1943 is one of the driest five. There are only 2 years on record showing less snowfall than 1943, when only 15 inches fell. In spite of a nearly normal growing season of 160 days, as determined by spring and fall frost dates, another record was established by 1943 with November 6th as an all time late date for the first killing frost.

Normally rain or snow will fall on 128 days in the year but umbrellas were called for on only 94 days in 1943. One hundred and one days were clear, as against an average number of 139. This loss of sunshine was partially compensated for by 133 partly cloudy days, compared to the average of 83. One hundred and thirty-one days were recorded as cloudy.

J. T. McClure

Climatological summary for 1943

Month	Temperature, degrees F.								Precipitation			Number of days—			
	Monthly mean	Departure from average*	Highest °F.	Highest Date	Lowest °F.	Lowest Date	Range	Greatest daily range	Average†	Departure from average	Average snowfall	With 0.01 in. or more precipitation	Clear	Partly cloudy	Cloudy
Wooster, Ohio															
January	26.7	—0.8	55	24	0	20	55	26	1.59	—1.48	5.00	11	1	10	20
February	28.8	1.2	59	23	—3	15, 18	62	38	1.34	—1.05	2.00	7	8	12	8
March	34.3	—3.1	71	31	0	3	71	35	3.17	—0.25	4.00	8	10	13	8
April	41.0	—7.2	72	27	20	4	52	36	2.28	—0.73	2.50	10	8	14	8
May	57.8	—0.9	80	6	29	2	51	27	6.27	2.54	.....	17	7	21	3
June	71.9	4.1	92	26	43	30	49	37	0.88	—3.03	.....	3	6	20	4
July	71.3	—0.5	89	14, 17, 26	39	1	50	38	5.72	1.68	.....	11	8	18	5
August	67.8	—2.0	89	1	42	19	47	35	3.44	—0.16	.....	5	19	6	6
September	59.9	—3.9	90	1	32	25	58	44	1.78	—1.37	.....	4	18	5	7
October	49.2	—2.7	81	12	27	20	54	44	1.70	—0.81	.....	8	14	3	14
November	36.6	—3.7	72	1	20	17, 29, 30	52	36	1.19	—1.41	1.25	7	1	6	23
December	27.4	—3.1	54	2	0	15, 24	54	30	0.67	—1.92	0.25	3	1	5	25
Annual	47.7	—1.9	92	June 26	—3	Feb. 15, 18	95	44	30.03	—7.99	15.00	94	101	133	131

*Years of record for Wooster, 56.
†Totals given for Wooster.

Climatological summary for 1943—Continued

Month	Temperature, degrees F.								Precipitation			Number of days—			
	Monthly mean	Departure from average*	Highest °F.	Highest Date	Lowest °F.	Lowest Date	Range	Greatest daily range	Average†	Departure from average	Average snowfall	With 0.01 in. or more precipitation	Clear	Partly cloudy	Cloudy
For Ohio															
January	29.5	1.0	78	24	−13	20	91	.....	1.80	−1.22	7.9	13	5	6	20
February	32.1	2.7	73	23	−13	15	86	.....	1.68	−0.91	2.9	10	10	8	10
March	37.3	−1.5	82	31	−13	8	95	.....	4.44	1.05	4.7	9	13	8	10
April	45.9	−3.9	81	27	11	15	70	.....	3.12	−0.05	1.4	14	10	8	12
May	61.2	0.6	93	6	22	22	71	.....	6.39	2.68	T	19	6	10	15
June	74.7	5.0	99	24, 25, 27	40	30	59	.....	3.37	−0.53	0	9	14	12	4
July	74.2	0.5	97	17, 28	38	1	59	.....	6.01	2.17	0	12	12	13	6
August	72.4	0.7	101	14	40	19	61	.....	2.88	−0.51	0	7	16	10	5
September	62.5	−3.1	100	1	30	18, 26	70	.....	1.83	−1.09	0	7	15	9	6
October	52.2	−1.4	87	1, 11	24	20	63	.....	1.76	−0.78	T	9	14	6	11
November	39.4	−2.1	84	1	9	28	75	.....	1.23	−1.45	1.2	9	9	7	14
December	29.4	−2.3	63	2‡	−10	15	73	.....	1.03	−1.68	2.2	6	10	8	13
Annual	50.9	−0.3	101	Aug. 14	−13	Jan. 20, Feb. 15, Mar. 8	114	.....	35.54	−2.33	20.3	124	133	107	107

*Years of record for Wooster, 56.
†Totals given for Wooster.
‡Data for Ohio furnished by Geo. W. Mindling, Section Director of the U. S. Weather Bureau at Columbus, Ohio.
T=Trace.

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644 Relationship Between Fat Content of Dairy Grain Mixtures and Milk and Butterfat Production.

645 A Comparative Study of Cotton and Rayon Glass Curtain Fabrics.

646 Food Consumption of College Men.

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648 The Ring-legged Earwig, *Euborellia annulipes* (Lucas).

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650 Farmers' Elevators of Ohio, Fifteen Years, 1928 to 1943.

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The Effect of Straw Mulch, Cultivation, and Nitrogen Fertilizer on the Growth and Yield of Latham Raspberries.
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FINANCIAL STATEMENT

July 1, 1943, to June 30, 1944

Consolidated Statement

ASSETS AND LIABILITIES

ASSETS

Current assets	$ 173,552.72	
Contingent assets	734,648.99	
Land	757,316.07	
Land improvements	70,222.29	
Buildings	675,924.02	
Departmental equipment	809,418.03	
Total assets		$3,221,082.12

LIABILITIES

Capital account	$2,486,433.13	
Special State appropriations	734,648.99	
Total liabilities		$3,221,082.12

INCOME AND EXPENDITURES

INCOME

Cash balance, July 1, 1943	$ 135,217.64	
Appropriations by State Legislature	567,913.94	
Appropriations from U. S. Government	206,679.41	
Sale of produce, etc.	206,001.56	
Total income		$1,115,812.55
Less funds paid to State Treasurer and not available for use by Station		52.50
Total available income		$1,115,760.05

EXPENDITURES

Salaries	$ 428,147.32	
Employees and extra labor	257,648.21	
Stationery and office supplies	4,215.68	
Incidentals	11,123.96	
Laboratory supplies	9,731.13	
Materials and general supplies	73,402.67	
Repairs to equipment	14,208.62	
Telephone and telegraph	3,873.65	
Freight and cartage	5,321.11	
Travel	12,388.02	
Feed	73,651.09	
Fertilizers	2,588.62	
Apparatus	2,097.64	
Furniture and fixtures	659.37	
Machinery, tools, etc.	19,494.70	
Library	1,452.91	
Livestock	22,202.63	
Total expenditures		$ 942,207.33
By balance forward		173,552.72
Total		$1,115,760.05

Respectfully submitted,
W. H. Kramer, Bursar

PROJECTS NOT REPORTED

Department of Agronomy

Influence of Quantity and Intensity Factors on the Utilization of Mineral Fertilizer by Crop Plants.

Response of New Wheat Varieties to Different Soil and Climatic Conditions.

The Mineral Nutrition of Hybrid Corn.

Development and Evaluation of Hybrid Corn for Ohio.

Breeding and Testing New Hybrid Sweet Corn Varieties.

Potash and Nitrogen Requirements of Corn and Oats as Affected by Sweetclover and Other Crop Residues.

Factors Influencing the Success of Seeding of Forage Crops.

Effect of Nitrogen Fertilization and Watering on the Composition, Yield, Distribution, and Persistence of Forage Grasses.

Causes of Failure of Lawn Grass Seeding under Drouth Conditions.

Development and Evaluation of Improved Varieties of Soybeans.

Potash Availability and Fertility Needs of Different Soils under Various Rotations and Soil Management Practices.

Improved Methods of Breeding Corn.

Performance Trials of Corn Hybrids.

Effect of Date and Method of Planting and of Fertility Level on Yield and Quality of Corn Hybrids.

Performance of Wheat Varieties Grown Alone and in Mixtures.

Wheat Competition in Nursery Tests.

Development and Evaluation of Improved Wheat Varieties.

Barley Variety Testing and Improvement.

Testing and Improving Oat Varieties for Ohio.

Culture and Management of Pastures for Chickens. (In Cooperation with Department of Animal Industry).

Heavy Fertilization of a Rotation for Hybrid Corn for Seed Production.

Rates and Placement of Nitrogen for Corn.

Mineral Composition of Ohio Soils.

Physical and Chemical Characteristics of Important Ohio Soils.

Fertilization of Soybeans with Nitrogen.

Defoliation of Soybeans with Cyanamid Dust.

Fry Farm Crop Rotation Experiments.

Grain versus Livestock Systems of Farming.

Preliminary Evaluation of New Forage Crop Strains.

Methods of Establishing Meadow Seeding in Rank-growing Wheat.

Sweetclover Breeding and Variety Evaluation.

Bromegrass Culture, Breeding, and Strain Testings.

Culture and Rotation Experiments with Soybeans.
Control of Field Weeds.
Evaluation of New Strains of Red Clover.
Lime and Phosphate Studies.
Fertilizer Placement for Corn.
Five-year Rotation Fertility Experiment.
Fertilization of Crops in Continuous Culture.
Value of Barnyard versus Shed Manure.
Lime and Floats Experiment.
Rates and Grades of Fertilizers for the Crop Rotation.
Methods of Applying Manure.
The Value of Limestone in Crop Production.
Supplementing Sweetclover as a Green Manure.
Corn Fertility Experiment.
Rotations and Fertility Practices for Rejuvenation of Eroded Land.
Minor Element Fertilization of Field Crops.
Rate of Fertilization of Wheat.
Cover Crops for Continuous Corn.
Soil Fertility Maintenance Practices on Major Soil Types of Ohio.
Crop Rotations for Sugar Beet Production.
Rate, Grade, and Placement of Fertilizers for Sugar Beets.
Use of Organic Matter, Crop Residues, and Manure for Sugar Beets.
Time and Method of Seedbed Preparation for Sugar Beets.

Department of Botany and Plant Pathology

Development of Leaf-mold Resistant Tomato Varieties Adapted for Glasshouse Vegetable Culture in Ohio.
Comparison of Vegetable Seed Treatments with Particular Reference to the Influence of Environmental Factors.
Methods of Fertilizing Shade Trees and the Effect of Fertilizer on Tree Vigor as Determined by Rate of Growth and Disease Resistance.
Apple Measles Disease or Internal Bark Necrosis of Apples.
The Diseases of Shade and Forest Trees and Other Woody Ornamental Plants.
Apple Tree Root Rot.
Comparative Trials of New Seed Protectants.
Investigation of Virus Diseases of Stone Fruits. (In Cooperation with Central States' Committee).
Control of Leaf Blight of Sugar Beets.

Department of Dairy Industry

The Value of Vitamin Capsules for Young Calves.
Vegetable versus Animal Protein in Calf Starters.
Simple versus Complex Grain Mixtures for Milk Production.
Raising Dairy Heifers on Roughage.
The Effect of Various Feeding Systems on the Vitamin A Content of Milk.

Department of Entomology

Codling Moth—Ecological Studies.
Codling Moth—Chemical Control.
Apple Aphids.
European Red Mite.
Potato Leafhopper and Potato Flea Beetle—Chemical Control on Early Potatoes.
Insect Pests of Stored Grains.
Chemical Control of Bean Pests.
Black Grain-stem Sawfly.
Hairy Chinch Bug on Lawns.
Tomato Fruit Worm—Chemical Control.
Corn Insects—Corn Root Worms, Ear Worms, Aphids.
White Grubs—Turf.
Plum Curculio—Emphasis on Insect as a Peach Pest.
Strawberry Insects.
Pests of Glasshouse Vegetables.
Development of New Pesticides.

Department of Horticulture

Fertilizers for Early Cabbage, Tomatoes, and Sweet Corn on Sandy Soil in Washington County.
Crop Rotations for Late Potatoes.
Fertilizers for Early Potatoes on Wooster Silt Loam.
Vegetable Variety Trials.
Hardening Tomato Plants with Nutrient Solutions.
Tomato Breeding.
The Effects of the Minor Elements Boron and Manganese upon the Quality of Vegetables with Especial Reference to the Tomato.
Muskmelon Breeding.
Fertilizer Application Methods for Shade Trees.
Fruit Understocks.
Mulches for Out-of-door Roses.

Tree Wound Dressings.

Variety Tests of Taxus.

The Effect of Adding Certain Vitamins, Hormones, Cereal Products, or Other Amendments to Mushroom Beds on the Growth and Yields of Commercial Mushrooms.

Breeding Greenhouse Vegetables.

The Effect of Different Soil Types, Different Levels of Soil Fertility, and Different Amounts of Soil Moisture on the Amount of Certain Minerals in Tomato Fruits.

Growth Promoting Chemicals in Relation to Fruit Set and Yield of Certain Horticultural Crops Grown for Their Fruits.

Causes of Irregular Fruit Setting in Several Representative Horticultural Plants with Particular Reference to Adjustments in Practice.

Growth and Fruitfulness of Certain Ohio Apple Varieties as Affected by Malling and Other Dwarfing Understocks and the Relative Value of Certain Hardy Varieties as Intermediate Stocks.

Effect of Growth Promoting Substances, Height of Heading, and Deshooting upon the Development of the Framework and Growth of Young Apple Trees.

Apple Breeding for the Purpose of Producing Late-blooming, Late-keeping Varieties Possessing Qualities Desirable for Commercial Use.

Test of New and Uncommon Pear Varieties, with Particular Reference to Tree Characters, Yield and Dessert Quality of the Fruit.

Time of Harvesting Beuree Bosc and Other Pears, with Particular Reference to Optimum Dessert Quality and Storage Behavior.

Caustic Sprays as a Means of Inducing Flower and Fruit Abscission in the Apple in Order to Replace Hand Thinning or to Change the Year of Alternation.

Pre-harvest Sprays.

The Interrelation of Auxin Concentration, Nitrogen Content, and Respiration Rate to the Growth Responses, Fruiting, and Storage Behavior of Several Horticultural Plants.

Soil Factors Which Limit the Yields of Grapes in Ohio and Other Factors, Such as Pruning and Planting Distance Which are Related to Production.

Peach Tree Behavior Under Different Cultural Treatments Which Affect Soil Organic Matter.

Stone and Small Fruit Variety Tests.

Soil and Cultural Treatments for Blueberries.

Labor-saving Devices with Cyclamen.

Soil Sterilization with Asters.

Growing Orchids in Gravel Culture.

The Culture of Carnations.

Variety Tests of Lilies.

The Causes and Controls of Scalds, Off-flavors, and Shriveling of Apples While in Storage.

Determination of the Replaceable Manganese Content of Ohio Orchard Soils, and the Relation to Such Other Nutrient Elements as Iron, Phosphorus, and Calcium.

The Farm Freezing Plant, Co-leader.

The Storage of Vegetables on Concrete and Wood Floors and Means of Shrivel Control.

Cover Crop and Green Manure-crop Rotations for Muck Soils.

Fertilizers for Muck Crops.

Selection of Superior Varieties and Strains of the Edible Soybean for Ohio Conditions.

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DEPARTMENT OF AGRICULTURAL ENGINEERING

DEPARTMENT OF AGRONOMY

DEPARTMENT OF ANIMAL INDUSTRY

DEPARTMENT OF BOTANY AND PLANT PATHOLOGY

DEPARTMENT OF DAIRY INDUSTRY

DEPARTMENT OF DISTRICT AND COUNTY FARMS

DEPARTMENT OF ENTOMOLOGY

DEPARTMENT OF FORESTRY

DEPARTMENT OF HOME ECONOMICS

DEPARTMENT OF HORTICULTURE

DEPARTMENT OF RURAL ECONOMICS AND RURAL SOCIOLOGY

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